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AN ECONOMIC STUDY OF MEXICO.

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IV.

TAXATION.—Of all the economic features of Mexico there is no one more novel, interesting, and instructive, and withal more antagonistic in its influence to the development of the country, than the system by which the Government—Federal, State, and municipal—raises the revenue essential to defray its necessary expenditures.

The general characteristics of the Mexican tariff, or system of taxing imports, have been already noticed. But one altogether anomalous and absurd feature of it remains to be pointed out. In all truly civilized countries, when foreign articles or merchandise have once satisfied all customs requirements at a port, or place of entry, and have been permitted to pass the frontier, they are exempted from any further taxation *as imports*, or so long as they retain such a distinctive character.* But, in Mexico, each State of the republic has practically its own custom-house system; and levies taxes on all goods—domestic and foreign—passing its borders; and then, in turn, the several towns of the States again assess all goods entering their respective precincts. The rate of State taxation, being determined by the several State Legislatures, varies, and varies continually with each State. In the Federal District—i. e., the city of Mexico—the rate was recently two per cent of the national tariff; but, in the adjoining State of Hidalgo, it was twelve and a half per cent, and in others it is as high as twenty-five per cent. The rate levied by the towns is said to be about nine per cent of what the State has exacted; but in this there is no

* The right to import is held to carry with it a right to sell on the part of the importer, without further restrictions, i. e., in the original packages. Thus, the United States Supreme Court has decided that a license-tax imposed by a State of the Federal Union, as a prerequisite to the right to sell an imported article, is equivalent to a duty on imports, and in violation of the provision of the Federal Constitution, which prohibits the States from imposing import duties; and the decision has been carefully recognized by the authorities of the several States in dealing with imported liquors under local license or other restrictive laws.

common rule. Thus, under date of April 9, 1886, an official of the Mexican National Railroad writes: "Goods destined for San Luis (i. e., *via* railway) pay a local tax in Laredo, Mexico, but on arrival at San Luis pay a municipal tax. These taxes are eternally changing, and are sometimes prohibitory. Take lumber, for example. Three months ago there was a municipal tax of thirty dollars per one thousand feet. This has now been reduced to one dollar per one thousand feet; but there is no certainty that the old tax will not be restored." Nor is this all. For the transit of every territorial boundary necessitates inspection, assessment, the preparation of bills of charges, and permits for entry; and all these transactions and papers involve the payment of fees, or the purchase and affixing of stamps. Thus, by section 377 of the tariff law of December, 1884, it is ordained "that the custom-house shall give to every individual who makes any importation, upon the payment of duties, a certificate of the sum paid, which certificate, on being presented to the administrator of the stamp-office in the place of importation, shall be changed for an equal amount in custom-house stamps. For this operation the interested party shall pay, to the administrator of whom he receives the stamps, two per cent in money (coin) of the total value of the stamps." All imports into Mexico at the present time are liable, therefore, to these multiple assessments; and the extent to which they act as a prohibition on trade may be best illustrated by a few practical examples.

In 1885, an American gentleman, residing in the city of Mexico as the representative of certain New England business interests, with a view of increasing his personal comfort, induced the landlady of the hotel where he resided (who, although by birth a Mexican, was of Scotch parentage) to order from St. Louis an American cooking-stove, with its customary adjuncts of pipes, kettles, pans, etc. In due time the stove arrived; and the following is an exact transcript of the bills contingent, which were rendered and paid upon its delivery:

ORIGINAL INVOICE:

1 stove	weight 282 pounds.		
1 box pipe	" 69 "		
1 box stove-furniture	" 86 "		
Total	437 pounds, or 199·3 kilos.		
Cost in St. Louis, United States currency		$26	50
Exchange at 20 per cent		5	30
Total		$31	80
Freight from St. Louis to city of Mexico (rail), at $3.15 per 100 pounds		$15	75
Mexican consular fee at El Paso		4	85
Stamps at El Paso			45
Cartage and labor on boxes examined by custom-house at El Paso			50
Forwarding commission, El Paso		2	00
Exchange 16¼ per cent on $7.64 freight advanced by Mexican Central Railroad		1	25
			$56 60

IMPORT DUTIES:

1 box, 128 kilos (stove), iron, without brass or copper ornaments, at 19 cents per kilo	$24 42	
1 box, 31·3 kilos, iron pipe, at 24 cents per kilo	7 51	
1 box iron pots, with brass handles, at 24 cents per kilo	9 48	
	$41 41	
Add 4 per cent as per tariff	1 65	
	$43 06	
Package duty, 50 cents per 100 kilos	1 00	
	$44 06	
Add 5 per cent as per tariff	2 20	
	$46 26	
Add 2 per cent municipal duty	93	
	$47 19	
Add 5 per cent consumption duty	2 36	
	$49 55	
Dispatch of goods at Buena Vista station, city of Mexico	38	
Stamps for permit	50	
		$50 43
		$107 03
Cartage in city of Mexico		75
Total		$107 78

RÉSUMÉ:

Original cost of stove, with exchange	$31 80
Freight, consular fees, and forwarding	24 80
Import duties	50 43
Cartage	75
Total	$107 78

[NOTE.—This stove was shipped from El Paso in a lot of goods for Messrs. —— & Co., the largest importing house in Mexico, thereby saving an expense of two thirds the consular fee—$14.56—which, if paid on the invoice alone, would have added $9.71 to charges, and raised the total to $117.49.]

In 1878 Hon. John W. Foster, then United States minister to Mexico, in a communication to the Manufacturers' Association of the Northwest (Chicago), thus analyzed the items of the cost, in the city of Mexico, of a tierce, weighing gross 328 pounds, containing 300 pounds (net) of sugar-cured hams:

New York cost, 300 pounds at 11 cents	$33 00
New York expenses, such as cartage, consular invoice ($4 gold), manifest, etc., average 5 per cent on large shipments	1 65
Freight from New York to Vera Cruz at 1 cent per pound, payable in New York	3 25
Exchange on New York, $37.90 at 18 per cent	6 82
Import duties in Vera Cruz, 138 kilos at 24 cents per kilo	33 12
Municipal duties in Vera Cruz, $1.03 for every 400 pounds	84
Lighterage and handling from steamer to warehouse ($1 to $1.50 per every 200 pounds)	1 63
Maritime brokerage, 2 per cent on freight ($3.25)	07

Opening and closing barrel	50
Additional charges in Vera Cruz for stamps and cartage to railroad-station, etc.	1 50
Commission in Vera Cruz, 2 per cent on $70.66	1 41
Exchange on Vera Cruz, 1 per cent on $39.06	39
Railroad freight from Vera Cruz to Mexico, 140 kilos, at $54.32 a ton	7 60
Local duties in city of Mexico, 2 per cent on Federal duty, $33.12	66
Local expenses in city of Mexico, cartage from depot, expenses in custom-house, etc	75
Total	$93 19

The net cost of one pound of imported American ham in the city of Mexico in 1878 was therefore 31 cents, or $1 in hams in New York was equal to $2.82 in Mexico!

A similar analysis showed an invoice of ten kegs of cut nails, costing two and a half cents per pound in New York, or $22.50, to have cost $14\frac{15}{100}$ cents per pound, or $141.64, when imported, in the city of Mexico; or $1 value in nails in New York was equal to $6.29 in Mexico. In the case of salt, costing $2 per barrel in New York, the cost of importation was $20.40; or $1 of salt in New York was equal to $10.20 in Mexico! And in the case of (Milwaukee) beer, a barrel costing, on board steamer in New Orleans, $13, cost $35.61 in the city of Mexico. It is clear, therefore, as Mr. Foster points out in connection with the above exhibits, "that articles of the most common use in the United States must be luxuries in Mexico, on account of their high price"; and that while "this would be the case, with such charges, in almost any country, however rich it might be, it is especially so in Mexico, where there is so much poverty."

Again, the Mexican tariff provides that the effects of immigrants shall be admitted free. "But this," writes an officer of the Mexican National Railroad Company, "is practically a dead letter, from the fact that interior duties are levied on everything the immigrant has, before he gets settled; and these are so great that no one goes. I've never known but one case go through Laredo. . . . A carpenter, or other mechanic, who desires to get employment in Mexico, has such heavy duties levied on his tools on passing the national or State frontiers, that few are willing or able to pay them. Hence few American mechanics find their way into the country, unless in accordance with special contract."

This practice of locally taxing interstate commerce is in direct contravention of an article in the Mexican Constitution of 1857, and it is said also of express decisions of the national Supreme Court. Several of the leading States of Mexico have at different times tried the experiment of prohibiting it by legislative enactments; but the States and municipalities of the country are always hard pressed to raise money for their current expenditures, and find the taxing of merchandise in transit so easy a method of partially solving their dif-

ficulties, that the Federal authorities have not yet been able, or, speaking more correctly, willing to prevent it.* It is important, however, to note here that, in the draft of the proposed reciprocity treaty between the United States and Mexico, it is provided that imports from the United States into Mexico, admitted free under the treaty, shall not be liable to any Mexican State duties.

The Mexican tariff system also provides for the taxation of exports, notably on the following products: gold bullion, one fourth of one per cent; silver bullion, one half of one per cent; coined gold and silver, having already paid at the mint, exempt; orchil, $10 per ton; wood for cabinet-work and construction, $2.50 per 31·3 American cubic feet. Small export duties are also imposed on coffee and heniquen. A revision of the Mexican tariff, with a view of modifying certain of its exorbitant duties, more especially those levied on the importation of wines and liquors and certain articles of food, has been recently recommended (1885) to the Government by a committee of delegates of prominent men of business from different parts of the republic.

The existence in a state of the New World of a system of taxation so antagonistic to all modern ideas, and so destructive of all commercial freedom, is certainly very curious, and prompts to the following reflections: First, how great was the wisdom and foresight of the framers of the Constitution of the United States in providing, at the very commencement of the Federal Union, that no power to tax in this manner, and for their own use or benefit, should ever be permitted to the States that might compose it (Article I, section 10). Second, how did such a system come to be ingrafted on Mexico, for it is not a modern contrivance? All are agreed that it is an old-time practice and a legacy of Spanish domination. But, further than this, may it not be another one of these numerous relics of European mediævalism which, having utterly disappeared in the countries of their origin, seem to have become embalmed, as it were, in what were the old Spanish provinces of

* In October, 1883, in response to a call of the President of the Republic, the Governors of the several States of Mexico appointed each two delegates, who assembled in convention at the capital, and after some deliberation published a report which exhibited the incompatibilities, disadvantages, and abuses of the system in the most convincing manner; but acknowledging, at the same time, that as all the State governments were more or less dependent upon it for their revenues, they could not recommend its present abolition. The report also concluded with a recommendation "that Congress should at once legalize a practice which a constitutional prohibition had failed to prevent, and which, under existing circumstances, it would be impolitic to suppress entirely." And, in deference to the suggestions of this conference, the Mexican Congress subsequently passed a law, with a view of modifying and limiting the authority of the State and municipal custom-house officers, so as to lessen in a degree the interruptions and vexations incident to the system. But as the Federal Government and some of the States have since then authorized public improvements to an extent that the state of their finances did not justify, and have in consequence increased taxes in all possible forms throughout the republic, the prospect for the complete suppression, or even of any essential modification, of this oppressive system of taxation is not flattering.

America—a system filtered down through Spanish traditions from the times when the imposition of taxes and the regulation of local trade was regarded by cities and communities in the light of an affirmation of their right to self-government, and as a barrier against feudal interference and tyranny; and when the idea of protecting industry through like devices was also not limited as now to international commerce, but was made applicable to the commercial intercourse of cities and communities of the same country, and even to separate trades or "guilds" of the same city? Whether such speculations have any warrant in fact or not, it is at least certain that we have in the Mexico of to-day a perfect example of what was common in Europe in the middle ages; namely, of protection to separate interests (through taxation) carried out to its fullest and logical extent, and also of its commercial and industrial consequences.

So much for the tariff system of Mexico. The "excise" or "internal revenue" system of the country is no less extraordinary. It is essentially a tax on sales, collected in great part through the agency of stamps—a repetition of the old "*alcavala*" tax of Spain,* which Adam Smith, in his "Wealth of Nations," describes as one of the worst forms of taxation that could be inflicted upon a country, and as largely responsible for the decay of Spanish manufactures and agriculture. Thus the Mexican law, re-enacted January, 1885, imposes a tax of "one half of one per cent upon the value in excess of $20 of transactions of buying or selling of every kind of merchandise, whether at wholesale or retail, in whatever place throughout the whole republic." Also, one half of one per cent "on all sales and resales of country or city property; upon all exchanges of movable or immovable property; on mortgages, transfers, or gifts, collateral or bequeathed inheritances; on bonds, rents of farms, when the rent exceeds $2,000 annually; and on all contracts with the Federal, State, or municipal governments." Every inhabitant of the republic who sells goods to the value of over $20 must give to the buyer "an invoice, note, or other document accrediting the purchase," and affix to the same, and cancel, a stamp corresponding to the value of the sale. Sales at retail are exempt from this tax; and retail sales are defined to be "sales made with a single buyer, whose value does not exceed $20. The reunion, in a single invoice, of various parcels, every one of which does not amount to $20, but which in the aggregate exceed that quantity," remains subject to the tax. Retail sales in the public markets, or by ambulatory sellers, or licensed establishments, whose capital does not exceed $300, are also exempt. Tickets of all descriptions—railroad, theatre, etc.—must have a stamp, as must each page of the reports of meetings; each leaf of a merchant's ledger, day or cash book, and every cigar sold singly, which must be delivered to the buyer in a stamped wrapper. Sales

* The very name is yet essentially kept up in Mexico, where the tax is sometimes designated as the "*alcabala*."

of spirits at wholesale pay three per cent; gross receipts of city railroads, four per cent; public amusements, two per cent upon the amount paid for entrance; playing-cards, fifty per cent—paid in stamps—on the retail price; and manufactured tobacco a variety of taxes, proportioned to quality and value. Mercantile drafts are taxed at $10 per $1,000, which means a dollar on every hundred.

Farms, *haciendas*, and town estates are required to be taxed at the rate of $3 per each $1,000 of the valuation, but such is the influence of the land-owners that the valuation is almost nominal. Land and buildings not actually producing income are exempt from taxation, notwithstanding they may be continually enhancing in value.*

In the towns, this system of infinitesimal taxation is indefinitely repeated; the towns acting as collectors of revenue for the Federal and State governments, as well as for their own municipal requirements. All industries pay a monthly fee: as tanneries, 50 cents; soap-factories, $1. So also all shops for the sale of goods pay according to their class, from a few dollars down to a few cents per month. Each beef animal, on leaving a town, pays 50 cents; each fat pig, 25 cents; each sheep, 12 cents; each load of corn, fruit, or vegetables, 6 cents, and so on; and, on entering another town, all these exactions are repeated. A miller, in Mexico, it is said, is obliged to pay thirty-two separate taxes on his wheat, before he can get it from the field and offer it, in the form of flour, on the market, for consumption. As a matter of necessity, furthermore, every center of population—small and big, city, town, or hamlet—swarms with petty officials, who are paid to see that not an item of agricultural produce, of manufactured goods, or an operation of trade or commerce or even a social event, like a *fandango*, a christening, a marriage, or a funeral, escapes the payment of tribute.

In fact, trade is so hampered by this system of taxation, that one can readily understand and accept the assertion that has been made, that people with capital in Mexico really dread to enter into business, and prefer to hoard their wealth, or restrict their investments to land (which, as before pointed out, is practically exempt from taxation), rather than subject themselves to the never-ending inquisitions and annoyances which are attendant upon almost every active employment of persons and capital, even were all other conditions favorable. Mexico, from the influence of this system of taxation alone, must, therefore, remain poor and undeveloped; and no evidence or argument to the contrary can in any degree weaken this assertion. Doubtless there are many intelligent people in Mexico who recognize the gravity of the situation, and are most anxious that something should be done in the way of reform. But what can be done? If autocratic powers were

* This practice of exempting unoccupied realty from taxation also prevails in Portugal. The theory there in justification of the practice is, that the use of a thing defines its measure of value, and that to tax unused property is a process of confiscation.

to be given to a trained financier, thoroughly versed in all the principles of taxation and of economic sciences, and conversant with the results of actual experiences, the problem of making things speedily and radically better in this department of the Mexican state is so difficult that he might well shrink from grappling with it.

In the first place, the great mass of the Mexican people have little or no visible, tangible property which is capable of direct assessment.

Again, in any permanent system of taxation, taxes in every country or community, in common with all the elements of the cost of production and subsistence—wages, profits, interest, depreciation, and materials—must be substantially drawn from each year's product. Now, the annual product of Mexico is comparatively very small. Thus, for example, Mr. Sutton, United States consul-general at Matamoros, as before noticed, has shown that the annual product of the single State of South Carolina is absolutely two and a half times—or, proportionally to area, twenty-five times—as valuable as the annual product of the entire northern half of Mexico; and the Argentine Republic of South America, with only one third of the population of Mexico, has a revenue twenty per cent greater, and double the amount of foreign commerce. Product being small, consumption must of necessity be also small. Ex-Consul Strother (report to State Department, United States, 1885) says: "The average cost of living (food and drink) to a laboring-man in the city of Mexico is about twenty-five cents per day; in the country from twelve and a half to eighteen cents. The average annual cost of a man's dress is probably not over five dollars; that of a woman double that sum, with an undetermined margin for gewgaws and cheap jewelry." Mr. Lambert, United States consul at San Blas, reports under date of May, 1884: "The average laborer and mechanic of this country may be fortunate enough, if luck be not too uncharitable toward him, to get a suit of tanned goat-skin, costing about six dollars, which will last him as many years."

The food of the masses consists mainly of agricultural products—corn (*tortillas*), beans (*frijoles*), and fruits, which are for the most part the direct results of the labor of the consumer, and not obtained through any mechanism of purchase or exchange.

Persons conversant with the foreign commerce of Mexico are also of the opinion that not more than five per cent of its population buy at the present time any imported article whatever; or that, for all purposes of trade in American or European manufactures, the population is much in excess of half a million. Revenue in Mexico from any tariff on imports must, therefore, be also limited; and this limitation is rendered much greater than it need be by absurdly high duties; which (as notably is the case of cheap cotton fabrics) enrich the smuggler and a few mill-proprietors, to the great detriment of the national exchequer.

It is clear, therefore, that the basis available to the Government

for obtaining revenue through the taxation of articles of domestic consumption, either in the processes of production, or through the machinery of distribution, is of necessity very narrow; and that if the state is to get anything, either directly or indirectly, from this source, there would really seem to be hardly any method open to it, other than that of an infinitesimal, inquisitorial system of assessment and obstruction, akin to what is already in existence.*

NOTE.—This curious tax experience of Mexico, although especially striking and interesting, is not exceptional, but finds a parallel, in a greater or less degree, in all countries of low civilization, small accumulation of wealth, and sluggish society movement. Thus, in the British island and colony of Jamaica, populated mainly by emancipated blacks and their descendants (554,132 out of a total of 580,804 in 1881), who own little or no land, and through favorable climatic conditions require the minimum of clothing and shelter, and little of food other than what is produced spontaneously, or by very little labor, the problem of how to raise revenue by any form of taxation, for defraying the necessary expenses of government, has been not a little embarrassing. For the year 1884, the revenue raised from taxation on this island represented an average assessment of about $3.40 per head of the entire population; but of this amount an average of about fifty cents only per head could be obtained from any excise or internal taxation; and this mainly through the indirect agency of licenses and stamps, and not by any direct assessment. The balance of receipts was derived from import and export duties, and from special duties on rum, which last furnished nearly one fourth of the entire revenue. During the same year the average taxation of the people of the United States—Federal, State, and municipal—was in excess of fourteen dollars per capita. A condition of things in British India, analogous to that existing in Jamaica, has for many years necessitated the imposition of very high taxes upon salt, as almost the only method by which the mass of the native population could be compelled to contribute anything whatever toward the support of their government; the consumption of salt being necessary to all, and its production and distribution being capable of control, and so of comparatively easy assessment. In short, if a man can avoid paying rent, make no accumulations, and will live exclusively on what he can himself gather from the bounty of Nature, he can not be taxed, except by a capitation or poll-tax; and it would be difficult to see how in such a case even such a tax could be collected. But, the moment he enters into society and recognizes the advantages of the division of labor and exchange, he begins to pay taxes, and the higher the civilization he enjoys the greater will be the taxes.

But the greatest obstacle in the way of tax reform in Mexico is to be found in the fact that a comparatively few people—not ten thousand out of a possible ten million—own all the land, and constitute, in the main, the governing class of the country; and the influence of this class has thus far been sufficiently potent to *practically* exempt land from taxation. So long as this condition of things prevails, it is difficult to see how there is ever going to be a middle class (as there is none now worthy of mention), occupying a position intermediate between the rich and a vast ignorant lower class, that take no interest in public affairs, and are only kept from turbulence through military restraint. Such a class, in every truly civilized and progressive coun-

* The experience of Mexico in respect to taxation ought to be especially instructive to all that large class of statesmen and law-makers in the United States who believe that the only equitable system of taxation is to provide for an obligatory return and assessment of all property, and that to exempt anything is both unjust and impolitic.

try, is numerically the greatest, and comprises the great producers; and because the great producers, the great consumers and tax-payers—for all taxes ultimately fall upon consumption—and so are the ones most interested in the promotion and maintenance of good government. A tax policy, however, which would compel the land-owners to cut up and sell their immense holdings, especially if they are unwilling to develop them, would be the first step toward the creation of such a middle class. But it is not unlikely that Mexico would have to go through one more revolution, and that the worst one she has yet experienced, before any such result could be accomplished. At present, furthermore, there is no evidence that the mass of the Mexican people, who would be most benefited by any wise scheme for the partition of the great estates and for tax reform, feel any interest whatever in the matter, or would vigorously support any leader of the upper class that might desire to take the initiative in promoting such changes. And herein is the greatest discouragement to every one who wishes well for the country.

The Federal budget, in respect to expenditures for the fiscal year 1886–'87, as reported by President Diaz to the Mexican Chamber of Deputies, was as follows:

Congress	$1,052,144
Executive Department	49,251
Judiciary	434,892
Ministry of Foreign Affairs	419,828
Ministry of Interior	3,539,364
Ministry of Justice	1,333,696
Ministry of Public Works	4,711,771
Ministry of Finance	12,004,270
Ministry of War and Navy	12,464,500
Total	$36,009,716

The estimates of receipts were uncertain. It was hoped, if business recovered, that they would reach $33,000,000; and the Government promised to try and restrict the national expenditures to this amount.

As for the sources of national revenue, the customs are understood to yield about one half; taxes on sales and stamps, some $5,000,000; post-offices and telegraph lines, $650,000; lotteries, $800,000; while the receipts from taxes levied by the States (mainly on sales also) amount to from $8,000,000 to $10,000,000, or about one half the receipts from customs.

In respect to the foreign commerce of Mexico, a report on the "Commercial Relations of the United States," issued by the United States Department of State in 1883, says: "Owing to the system, or, rather, to the lack of system, in regard to the collection and publication of customs returns by the national Government, it is impossible for our consuls in Mexico to supply any trustworthy statistics concern-

ing the foreign commerce of the republic." An approximative estimate of the results for 1880 was as follows:

Exports	$32,663,554
Imports	24,003,372
Total	$56,666,926

The precious metals—coin, bullion, and ores—always constitute the great bulk of what Mexico exports; and the proportion of agricultural products or other merchandise exported is surprisingly small. Thus, out of the total value of exports for 1884, estimated by Consul-General Sutton at $39,716,000, nearly three fourths, or $28,452,000, were credited to the precious metals, and only $11,264,000 to all other commodities; and, of these last, the largest proportion always consists of articles produced near the seaboard, or near the line of the City of Mexico and Vera Cruz Railroad. During recent years, and since the construction of the so-called American railroads, the increase in the exports from Mexico, of products other than the precious metals, has, however, been very notable, and is apparently progressive. But the fact that the exports of Mexico *always* largely exceed her imports, that the great bulk of the exports are *always* the precious metals, and that the excess of imports does not represent payment for interest to any extent on any national foreign indebtedness, naturally creates a suspicion that the whole (export) transaction is something abnormal; which may find an explanation in the existence of a class of wealthy absentee landlords, or proprietors, who, living permanently in Paris or Spain, draw rents, tolls, and profits from their Mexican properties, and invest or expend the same in other, or foreign countries. The bulk of the coinage of Mexico—both of silver and of gold—is exported almost as soon as it leaves the mints. Thus, although the average annual coinage of the Mexican mints from 1876 to 1880 was $22,524,694, and since then has been larger ($25,610,000 in 1881–'82), the amount of coin in actual circulation in the country is believed to have never been in excess of $15,000,000 or $20,000,000. Much of the Mexican coined silver has, as is well known, been heretofore in large demand to meet the world's requirements for trade with China; but what has come back to Mexico for it in exchange is somewhat of a commercial puzzle.

In a report to the State Department (May, 1884), ex-Consul-General Strother thus briefly sums up the obstacles (heretofore noticed more in detail in this series of papers) which stand in the way of the future development of the commerce of Mexico. He says: "Topographically considered, Mexico labors under many serious disadvantages to commerce, whether external or internal. Her coasts on both oceans are broad belts of intolerable heat, disease, and aridity, and, except a few small seaport towns, are nearly uninhabited. On the whole extent of her coast-line there are but two natural harbors available

for first-class modern merchant-vessels—those of Anton Lizado on the Gulf, and Acapulco on the Pacific. All the other so-called seaports now used by commerce are open roadsteads, dangerous in rough weather, and only approachable in lighters, or are located on rivers, the entrances to which are closed to ocean traders by shallows or sand-bars. The natural obstructions and difficulties in the way of inland traffic are scarcely less observable. Mexico is entirely wanting in navigable rivers and lakes. Her fertile districts, capital cities, and centers of population are separated from each other by long distances, arid districts, immense chains of mountains, and vast *barrancas* washed out by her rapidly descending water-courses. These difficulties were partially overcome by the Spaniards, who constructed a noble system of highways and bridges extending between the principal cities of the viceroyalty, but from the nature of the soil they were immensely expensive to construct and difficult to maintain. During the long and ruinous wars for independence, and the civil wars which followed, these highways went rapidly to destruction; and, notwithstanding recent repairs and reconstructions, the general condition of Mexican highways is not encouraging to either commerce or travel. But all these natural and accidental disadvantages combined may be regarded as nothing in comparison with the crushing and suffocating influences brought to bear on Mexican commerce, foreign and domestic, by the exclusive policy imposed by the mother-country during the three centuries of Mexico's colonial vassalage; and, secondly, by the system of internal and interstate duties and custom-houses, inherited from Old Spain, which still practically vexes the internal commerce of the republic."

Relation of the Sanitary Condition of Mexico to its Commercial Development.—The sanitary condition of every country constitutes an important element in determining its commercial development, and Mexico especially illustrates the truth of this proposition. The coast-lands of the republic are hot and unhealthy. The more elevated portions, where nine tenths of the people live, are claimed to be unsurpassed in salubrity. Strangers from northern latitudes, and accustomed to the ordinary levels of human residence, are liable, on coming to the Mexican plateau, to a process of acclimation, which, although often very trying, is rarely attended with any very serious consequences. Horse-dealers from Texas state that they lose from twelve to twenty per cent of the horses brought to the city of Mexico for sale, solely from the climatic influences contingent on its great altitude; and the common house-cat, it is said, does not thrive, and is scarce on the highlands of Mexico for like reasons. The sanitary conditions of the two chief commercial centers of the republic, namely, the city of Mexico and of Vera Cruz, are, however, so extraordinary and so obstructive to national progress that any review of the country would be imperfect that neglected to notice them. The evil in the

case of the former is local and not climatic, and is due to the circumstance that the site of the city is "a bowl in the mountains," so that drainage from it is now, and always has been, very difficult. And, as years have passed, and the population living within the bowl has multiplied, the evil has continually increased, until Lake Tezcoco, which borders the city, and on which Cortes built and floated war-galleys, has been nearly filled up with drainage deposits which have been carried into it through an elaborate system of city sewers. If these sewers ever had fall enough to drain them, they have, as the result of the filling up of this lake, little or none now, and the result is that they have become in effect an immense system of cess-pools; while the soil, on which from 250,000 to 300,000 people live, has become permeated throughout with stagnant water and filth inexpressible. And were it not for the extreme dryness and rarefaction of the air, which, as before pointed out, prevent the putrefaction of animal substances, and seem to hinder the propagation of the germs of disease, the city must long ago have been visited with plague, and perhaps have been rendered absolutely uninhabitable. And, even under existing circumstances, the average duration of life in the city of Mexico is estimated to be but 26·4 years. Typhoid fever prevails all the year round, and is especially virulent at the end of the dry season, when the heat is the greatest. And, surprising as it may seem, with a climate of perpetual spring and an elevation of 7,500 above the sea-level, lung and malarial diseases hold a prominent place among the causes of death. According to the reports of the Board of Health of the Mexican capital for April and May of the present year (1886), thirty-three per cent of the weekly mortality at that season was to be referred to typhoid and other forms of gastric fever, and twenty per cent to consumption and pneumonia. In the year 1877, when a typhus epidemic prevailed, the city's mortality was reported to have been as high as 53·2 per thousand as compared with an average death-rate of 24·6 in Paris for the same year. "A distinguished member of the medical faculty of Mexico has lately published a report, in which he demonstrates, by comparative statistical tables, that the annual mortality of the city is increasing to such an extent as already to counterbalance the natural movement of the population, and, if not checked in time, as threatening the race." *—"United States Consular Reports," No. 3, 1881, p. 18.

This condition of affairs is not due, as some might infer, to any improvidence or want of enterprise on the part of the Mexicans, for

* Under the title of the "Great Necropolis," one of the prominent Mexican newspapers, the "Correo del Lúnes," recently said: "Undisguised terror is caused by these processions of the dead which daily defile through the streets of Mexico. To be alive here is getting to be a startling phenomenon. It may be a very short time, unless energetic remedial measures are adopted, before the capital will have to be moved to another location."

the evil has long been recognized, and at present especially interests the Government. But the difficulties in the way of applying an efficacious remedy are very great, and engineers are not fully agreed as to the best method for attaining the desired result. "For such is the nature of the plain upon which Mexico is built, such the conformation of the land and the contour of the mountains about it, that a vast system of tunneling and canalization would be necessary to create a fall sufficient to drain the valley; and, before the city can be drained, the valley must be." It is said that one celebrated American engineer, whose advice was recently asked by the Government, reported that, if a thorough drainage could be effected, the city, through a consequent shrinkage of soil, would probably tumble down. And, finally, the existing condition of the national and municipal finances is such, that it is not easy for the authorities to determine how the money necessary to meet the contingent great expenditures—estimated at about $9,000,000, or a sum equivalent to more than one third of the entire annual revenue of the General Government—is to be provided.

It ought not to be inferred that there is special danger to travelers, or tourists, visiting the Mexican capital, and residing there during the winter months or early spring; for experience shows that, with ordinary precautions in respect to location, diet, exercise, and exposure, health can be maintained there as easily as in most of the cities of Italy at the same seasons.

At Vera Cruz, the local name of which is "El Vomito" (a term doubtless originating from the continued prevalence in the town of yellow fever), the sanitary conditions are much worse than in the city of Mexico; and the causes of the evil, being mainly climatic, are probably not removable. The statistics of mortality at this place, gathered and published by the United States Department of State, are simply appalling. Thus, the population of Vera Cruz in 1869 was returned at 13,492. The number of deaths occurring during the ten years ending September, 1880, was 12,219. The average duration of life in Vera Cruz for this period was, therefore, about eleven years! Other calculations indicate the average annual death-rate of this place to be about ninety per thousand, as compared with the annual average for all the leading cities of the United States for the year 1880, of 22·28 per thousand.

The writer feels that he would be guilty of a grave omission, in this connection, if he failed to quote and also to indorse the words with which the United States consul, who gathered and communicated these facts, thus concludes his official report, October, 1880: "With these awful facts before me, I leave it to the common judgment and high ideas that our law-makers have of justice to say whether or not the salary of the consul who, for eleven years, has lived in such an atmosphere, ought or ought not to be placed at least back to where it was when he was sent here."

[NOTE.—No more striking illustration of the popular "craze" for public office can be found than in the circumstance that, although an appointment to the United States consulate at Vera Cruz (salary in 1884, $3,000) is equivalent to investing in a lottery of death, in which the chances to an unacclimated person for drawing a capital prize are probably as great as one to seven or eight, no lack of applicants for the place is ever experienced. Thus, the consul whose appeal for an increase of salary is above noticed, was appointed from Illinois, and resigned in 1881. His successor, appointed from Nebraska, died of yellow fever a fortnight after arrival at his post; and since then there have been two appointments, one from Nebraska and one from New Jersey.]

This, then, is what the writer has to report respecting the economic condition and prospects of Mexico. His conclusions have not come to him, as perhaps may be inferred or charged, mainly from a somewhat extended but brief tour of observation; for no one can be more conscious than he of how little one can know of a country who, ignorant of the language, the customs, the political and social condition and pursuits of its people, sees it simply and hurriedly as a traveler. But the journey in question was, nevertheless, sufficiently extensive and instructive to thoroughly satisfy at least as to two points: First, that here was a country, bordering on the United States for a distance of more than two thousand miles, which was almost as foreign to the latter, in respect to race, climate, government, manners, and laws, as though it belonged to another planet; and, secondly, that the people of the United States generally knew about as much of the domestic concerns of this one of their nearest neighbors as they did about those of the empire of China. The temptation to enter upon a field of economic investigation so fresh and so little worked was too attractive to be resisted; and, accordingly, with the sole purpose of desiring to know the truth about Mexico, and to form an opinion as to what should be the future political and commercial relations between that country and the United States, the writer has made a careful study of a large amount of information that he has found accessible, both from public and private sources. And it is on the basis of this study, and with the kindliest feeling for and the deepest interest in Mexico, that he has written. In so doing, however, he claims nothing of infallibility. He frankly confesses that in respect to some things he may be mistaken; and that others might draw entirely different conclusions from the same data.* But for the entire accuracy

* One curious illustration of this point is to be found in the following extract from a letter recently addressed to the Mexican "Financier" by a Mexican gentleman, in contravention of the writer's opinions respecting the present industrial condition and prospective development of Mexico. He says: "If you pass through the Academy of San Carlos, you will see pictures executed by native Mexican artists in the highest style of art, comparing most favorably with any production of the academies of design of Paris, Rome, Munich, or elsewhere. Go with me, if you please, to a narrow lane in the small but picturesque city of Cuernavaca, and there in a small room, working with implements of his own make, you will observe a native, whom you would perhaps class among the peons, carving a crucifix in wood, so highly artistic, with the expression of suffering on our Saviour's face so realistic, that any foreign sculptor of the highest renown would be proud to call it a

of most statements and deductions, he believes he finds ample warrant in the published diplomatic and consular correspondence of the United States during the last decade, and in an extensive personal correspondence with railroad and commercial men, who, from continuous residence, have become well acquainted with Mexico.* Making every allowance, however, for differences of opinion respecting minor details, the main facts and deductions that have been presented (which can not well be questioned or disputed) are all that are essential for an intelligent discussion of the possible or desirable relations of the United States to Mexico in the future; and it is to a consideration of this matter that the attention of the reader is next invited.

creation of his own. Again, visit with me the village of Amatlan de los Reyes, near Córdoba, and observe the exquisitely embroidered *huipilla* of some native woman, surpassing in many respects the designs of the art-needlework societies of New York or Boston; not to mention the fine filigree-work, figures in clay and wax as executed by the natives in or near the city of Mexico, the art pottery of Guadalajara, the gourds, calabashes, and wooden trays highly embellished by native artists, whose sense or acceptation of art is not acquired by tedious study at some academy of design, but is inborn and spontaneously expressed in such creations. Only yesterday in my walks about town I entered the National Monte de Piedad, where I heard the sweetest and most melodious strains from a grand piano of American make, and beheld, to my astonishment, that the artist was a native, a *cargador*, or public porter, clad in cheap *sombrero*, blouse, white cotton trousers, and sandals, with his brass plate and rope across his shoulders, ready to carry this very instrument on his back to the residence of some better-favored brother from a foreign land. If this is not innate genius, I know not what else to call it" To this it may be replied that the facts as above stated are probably not in the least exaggerated. There is undoubtedly in the Mexican people, inherited from their Spanish ancestry, much of æsthetic taste and an "innate genius" for music, painting, sculpture, embroidery, dress, decoration, and the fine arts generally. But this very fact, in view of the hard, rough work that Mexico has got to do to overcome the natural obstacles in the way of her material development, is not a matter of encouragement. For it is not genius to carve crucifixes, embroider *huipillas*, or compose and execute music that her people need; but rather the ability to make and maintain good roads, invent and use machinery, and reform a system of laws that would neutralize all her natural advantages, even though they were many times greater than the most patriotic citizen of the country could claim for it.

* From one of these latter the following warning against publishing anything in the way of observations or conclusions was received by the writer:

"City of Mexico, *April* 13, 1886.

"The papers are filled with the letters of travelers about Mexico. If you do not conform to what many people here want you to say, you are put down as having taken a hasty or dyspeptic observation of the country, and had no opportunity to know anything. If you pass one week in an hotel, and should write conformably to what various interests wou'd have you, you are at once quoted as a 'most intelligent and experienced traveler.' A thorough investigation scrapes off all the varnish, and will often expose the motives of not a few people in Mexico, who would have American capital plant itself there under conditions which afford no protection by their Government or ours."

EARTHQUAKES AND OTHER SEISMIC MOVEMENTS.*

WE are accustomed to think of the land of the earth as something solid and fixed; and, as a testimonial of this impression, the Latin phrase *terra firma*, firm land or solid ground, has been naturalized in the languages of nearly all civilized peoples. On the other hand, we speak of water as unstable. But the geological history of the earth and the more careful observations of modern times have taught us that these ideas do not correctly represent the qualities of the land-masses and water-masses of the globe as compared with one another. The ancient shore-marks on the continents and the phenomena of elevation and subsidence that have been observed in historic times, confirming their evidence, show that the land and the ocean are continually changing their level as to one another; and it has further been made evident, by experiment, as well as by *a priori* reasoning, that it is not the ocean that changes, but the land which undergoes alternate movements of elevation and depression. An earthquake-shock is a phenomenon well adapted to destroy the faith of any person who feels one in the fixedness of the earth; and such, by the evidence, is the effect for the time on all who experience these shocks. Even the light pulsations which sometimes pass over parts of the United States occasion panic and excite a momentary impression that everything is falling over or sinking away; while the more violent shocks that are felt in earthquake-infested countries produce indescribable terror; and such catastrophes as those historical earthquakes of Lisbon and Caracas, and the more recent ones of Ischia and the Strait of Sunda amount to a demonstration that the reason for such terrors is real, and that the continents also can not escape the general law of change and perishability.

Earth-movements—the name by which these phenomena may be most conveniently described—are various, and comprise, so far as they are now considered, earthquakes, or sudden violent movements of the ground; earth-tremors, or minute movements which usually escape attention by the smallness of their amplitude; earth pulsations, or movements which are overlooked on account of the length of their period; and earth oscillations or movements of long period and large amplitude—like the shifting of levels of land-masses—which attract attention from their geological importance. Some of these movements have only recently begun to attract attention. They are all intimately associated in their occurrence and their origin.

The study of earthquakes is of interest to the geologist in many

* Earthquakes and other Earth Movements. By John Milne, Professor of Mining and Geology in the Imperial College of Tokio, Japan. International Scientific Series. No. LV. New York: D. Appleton & Co., pp. 348.

ways. As they seem to be connected with volcanic action, the study of them may help to throw light on that, and *vice versa*. As an earthquake-wave travels along from strata to strata, the study of its reflections and changes in transit may lead to the discovery of peculiarities in rocky structure, of which we should otherwise have no accurate knowledge. It may teach us something about the transmission of disturbances in elastic media, about the earth's magnetism, the electric currents of the earth, and other kindred problems. It is of interest to the meteorologist to know the connections which probably exist between earthquakes and the fluctuations of the barometer, the changes of the thermometer, and the quantity of rainfall. In a practical point, we may ask ourselves what are the effects of earthquakes upon buildings, and how, in earthquake-shaken countries, the buildings are to be made to withstand them.

A typical earthquake consists of a series of small tremors succeeded by a shock, or of a series of shocks separated by more or less irregular —both in period and in amplitude—vibrations of the ground. Man can take but little account of these movements, for they come upon him by surprise, and, by the time he is ready to begin to observe, they are over. Hence we must have recourse to instruments. It is easy enough to construct an instrument that shall move at the time of an earthquake, and leave a record of its motion—a *seismoscope;* but an instrument that shall record the period, extent, and direction of each of the vibrations constituting the earthquake—a *seismometer* or *seismograph*—is a more complicated affair.

FIG. 1.

The earliest seismoscope of which we find any historical record is that of the Chinese Chôko, which was invented in A. D. 136. According to the historical account given of it, it consisted of a spherically formed copper vessel (Fig. 1), eight feet in diameter. "Its outer part," the account says, "is ornamented by the figures of different kinds of birds and animals, and old, peculiar-looking letters. In the inner part of this instrument is a column so suspended that it can move in eight directions. Also, in the inside of the bottle, there is an arrangement by which some record of an earthquake is made according to the movement of the pillar. On the outside of the bottle there are eight

dragon-heads, each of which holds a ball in its mouth. Underneath these heads there are eight frogs so placed that they appear to watch the dragon's face, so that they are ready to receive the ball if it should be dropped. All the arrangements which cause the pillar to knock the ball out of the dragon's mouth are well hidden in the bottle. When an earthquake occurs, and the bottle is shaken, the dragon instantly drops the ball and the frog which receives it vibrates vigorously. Any one watching this instrument can easily observe earthquakes. With this arrangement, although one dragon may drop a ball, it is not necessary for the other seven dragons to drop their balls unless the movement has been in all directions: thus we can easily tell the direction of an earthquake. Once upon a time a dragon dropped its ball without any earthquake being observed, and the people therefore thought the instrument of no use, but after two or three days a notice came, saying that an earthquake had taken place at Rôsei. Hearing of this, those who doubted the use of this instrument began to believe in it again. After this ingenious instrument had been invented by Chôko, the Chinese Government wisely appointed a secretary to make observations on earthquakes." This, the most ancient of the whole class, is closely resembled by some of the instruments of modern times.

The Japanese have an instrument consisting of a magnet holding up a nail, which, when shaken off, starts the train of an alarum, but this does not seem to have ever acted with success. Other seismoscopes depend upon the overthrow of a round column of wood or metal, the projection of balls which are connected with electric circuits, or the disturbance of liquids. Some seismographs depend upon the motions of a pendulum, which may be made to show whether the direction of the shock has been constant or variable, and the maximum extent of its motion in various directions. Other instruments are formed by various adjustments of movable bodies, or with springs and adaptations of clock-work. For a complete seismograph we require three distinct sets of apparatus—an apparatus to record horizontal motion, one to record vertical motion, and one to record time. These principles are all embodied in the Gray and Milne seismograph, which is now in use in Japan. In this apparatus (Fig. 2) two mutually rectangular components of the horizontal motion of the earth are recorded on a sheet of smoked paper wound round a drum, D, kept continuously in motion by clock-work, W, by means of two conical pendulum seismographs, C. The vertical motion is recorded on the same sheet of paper by means of a compensated-spring seismograph, S. L. M. B. The time of occurrence of an earthquake is determined by causing the circuit of two electro-magnets to be closed by the shaking. One of these magnets relieves a mechanism, forming part of a time-keeper, which causes the dial of the time-piece to come suddenly forward on the hands and then move back to its original position. The hands are

provided with ink-pads, which mark their positions on the dial, thus indicating the hour, minute, and second when the circuit was closed. The second electro-magnet causes a pointer to make a mark on the paper receiving the record of the motion. This mark indicates the part of the earthquake at which the circuit was closed. The duration

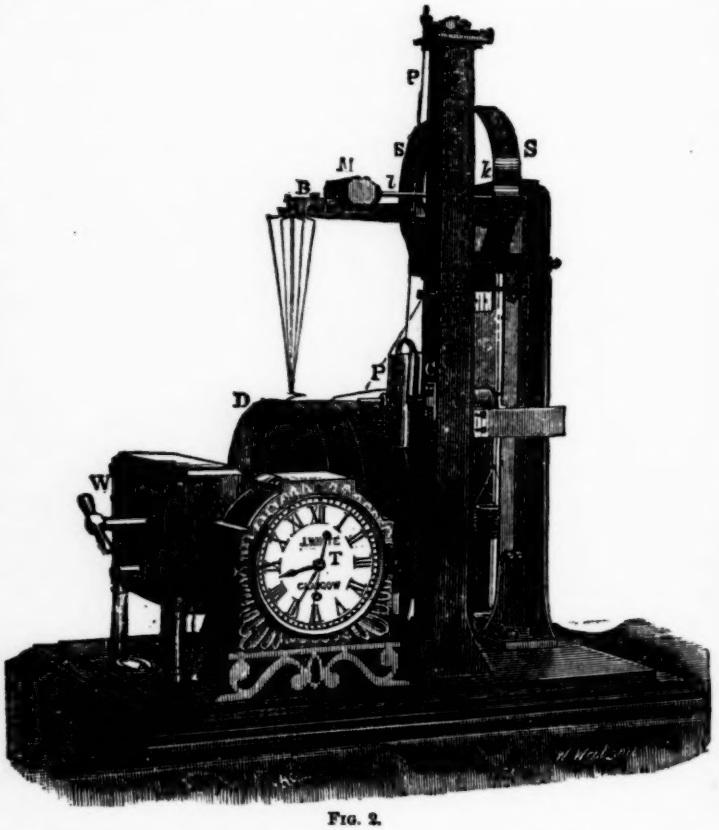


FIG. 2.

of the earthquake is estimated from the length of the record on the smoked paper and the rate of motion of the drum. The nature and period of the different movements are obtained from the curves drawn on the paper.

It may be said, as the result of experiences and observations, that an ordinary earthquake consists of a number of backward-and-forward motions of the ground following each other in quick succession. Sometimes these commence and die out so gradually that those who have endeavored to time the duration of an earthquake have found it difficult to say when the shock began and when it ended. Sometimes the motions gradually increase to a maximum and then die out as gradually; sometimes the maximum comes suddenly; and at other times

during an earthquake the observer's feelings distinctly tell him that there are several maxima. The chief results which investigators have aimed at have been the measurement of the amplitude, period, direction, and duration of the motions; and attention has been given to the velocity with which the disturbance is propagated.

If we were to ask the inhabitants of a town which had been shaken by an earthquake the direction of the motion they had experienced, it is not unlikely that their replies would include all the points of the compass. Many, in consequence of their alarm, have not been able to make accurate observations. Others have been deceived by the motion of the building in which they were situated. Some tell us that the motion was north and south, while others say that it was east and west. A certain number have recognized several motions, and among the rest there will be a few who have felt a wriggling or twisting. Leaving out exceptional cases, the general result obtained from personal observation as to the direction of an earthquake of moderate intensity is extremely indefinite, and the only satisfactory information to be got is that derived from instruments or from the effects of the earthquake as exhibited in shattered buildings and bodies which had been overturned or projected. By the use of seismographs it has been shown that during an earthquake the ground may move in one, two, or several directions, and it is only when a decided shock is experienced that we can determine with any confidence the direction in which the motion has been propagated. The apparently twisting or wriggling motions are supposed to be the result of combinations of linear movements in different directions. It is often difficult, when reading accounts of earthquakes, to determine the length of time a shaking was continuous. Disturbances which succeed one another with sufficient rapidity to cause an almost continual trembling of the ground may be regarded as collectively forming one great seismic effort, which may last a minute, an hour, a day, a week, or even several years. Strictly speaking, they are a series of separate earthquakes, the vibrations of which more or less overlap. Whenever a large earthquake occurs, it is generally succeeded by a considerable number of smaller shocks. Disturbances of this character are compared by Mallet to "an occasional cannonade during a continuous but irregular rattle of musketry." Continuous motions perceptible to our senses without the aid of instruments usually last from thirty seconds to about two or three minutes. The principal vibrations or shocks of the disturbance occur at unequal intervals; and in the periods of vibration there are irregularities in any given earthquake, and different earthquakes differ from one another. The extent of the movement is much less than the feelings of one experiencing a shock would lead him to estimate it. It is usually within the fraction of an inch in either direction. According to Dr. Wagener, the earth's horizontal motion at the time of a small earthquake is usually only the fraction of a millimetre, and it seldom exceeds three or

four millimetres. Mallet believes that the displacement may in some instances be equal to a foot; and M. Abella records a rough observation, in the Philippine Islands, of a motion of the earth to a distance of two metres, when fissures were formed, and seen to open and shut. The velocity of propagation of the wave may vary, even in the same country, between several hundreds and several thousands of feet per second. The same earthquake travels faster across districts near to its origin than it does across districts which are far removed; and, the greater the intensity of the shock, the greater is the velocity.

If we were suddenly placed among the ruins of a large city which had been shattered by an earthquake, it is doubtful whether we should at once recognize any law as to the relative position of the masses of rubbish and the general destruction around. The results of observation have, however, shown that, among the apparently chaotic ruin produced by earthquakes there runs more or less of law governing the position of bodies which have fallen, the direction and position of cracks in walls, and the other effects. Usually, walls of buildings at right angles to the shock will be more likely to be overthrown than those which are parallel to it. It is said that in Carácas every house has its *lado securo*, or safe side, where the inhabitants place their fragile property. It is the north side, and has been chosen because about two out of three destructive shocks traverse the city from west to east, so that the walls in those sides of the building take them broadside on. This appears to be the rule in destructive earthquakes. But, when a building is subjected to a slight movement, it is assumed that the walls at right angles to the direction of the shock move backward and forward as a whole, and there is little or no tendency for them to be fractured at their weaker parts. The walls, however, which are parallel to the direction of the movement are extended and contracted along their length, and may consequently be expected to give way over the door- and window-openings. The results of the examination of more than three hundred foreign-built brick houses in Tokio, Japan, all similar in their construction, are typically illustrated in Fig. 3. They show that in the upper windows nearly all the cracks ran from the springing of the arches, which formed an angle with the abutment. In the lower arches, which curved into the abutments, not a single crack was observed at the spring-way. The cracks in those arches were near the crown, where beams projected to carry the balcony; and in many instances they proceeded from such beams, even if there were no arches beneath. The houses which were most cracked were in the streets running parallel to the direction in which the greater number and most powerful set of shocks cross the city. From the fact that cracks once made in a building did not appear to extend under the repetition of shocks similar to the one that produced them, it has been inferred that buildings thus cracked acquire a degree of

flexibility, and that, by providing cracks or joints between the parts of buildings which have different periods of vibration, some of the strain might be taken off from them, and they might be made more stable. In stone-work, the cracks have been observed generally to run through the mortar-joints; in brick-work, through either bricks or mortar, often preferring the bricks.

As fractures in walls seem most likely to take place above openings like doors or windows, it follows that where architecture demands that openings should be placed one above another in heavy walls, there will be lines of weakness running through the openings. As arches are only intended to resist vertical thrusts, special construction must be adopted to make them strong enough to resist horizontal pulls. This might be given by inserting iron girders or wooden lintels in the arches. Mr. Perry, of Tokio, has suggested a plan of building so that the openings of each tier would occupy alternate positions. Such a line is shown in Fig. 4, where the dotted lines run through openings

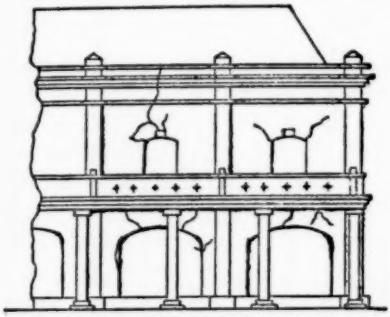


FIG. 3.—BRICK BUILDINGS IN TOKIO, SHOWING FRACTURES.

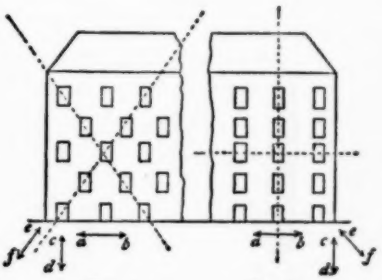


FIG. 4.

FIG. 5.

representing the direction of the lines of weakness. If we compare this with Fig. 5, we shall see that in the case of a horizontal movement, *a b*, or a vertical movement, *c d*, fractures would more probably occur in a house built like Fig. 5 than in one built like Fig. 4. If, however, these two buildings were shaken by a shock which had an angle of emergence of about 45°, in the direction of *e f*, the effects might be reversed. Fractures following a vertical line of weakness are shown in the accompanying drawing (Fig. 6) of the church of St. Augustin, at Manila, shattered by the earthquake of 1880.

When an earthquake shock enters and proceeds along a line of buildings, the last building in the row will, of course, suffer the most, and will exhibit the greatest tendency to fly away from its neighbors. If the house stands on the edge of a canal, or cliff, this tendency is increased by the similar motion of the escarpment. The fate of an end-building thus stricken is shown in Fig. 7, which is taken from the photograph of a house that was shattered in 1868 at San Francisco. Houses may also be rocked on their foundations, or even

quite overturned, as appears to have happened to the stud-mill at Hayward, California (Fig. 8).

In any building which may be affected by an earthquake, we have to consider the vibration of a number of parts, the periods of which, if they were independent of each other, would be different. On account of this difference in period, while one portion of a building is

FIG. 6.—CHURCH OF ST. AUGUSTIN, MANILA. EARTHQUAKES OF JULY 18-20, 1880.

endeavoring to move toward the right, another is pulling toward the left, and either the bonds which join them or the parts themselves will be strained or broken. This was illustrated by many of the chimneys in the houses at Yokohama, which, in the earthquake of February 20, 1880, were shorn off just above the roof. Since then, builders have learned to let chimneys pass freely through the roof without coming in contact with any of the main timbers.

In trying to make structures earthquake-proof, we may build our house weak and flexible, so that the shock shall pass over it as the wind over a reed, or we may attempt to make it stronger than the shock. The native Japanese houses, with their flexible framing, are built on the former plan; some of the European houses essay the

latter. In Italy the houses are left to take their chances. In South America, where much exposed to earthquakes, they are built of only one story, or of bamboo and ropes, similarly to the Japanese plan. One of the safest houses for an earthquake country would probably be a one-storied, strongly framed timber house, with a light, flattish roof,

FIG. 7.—WEBBER HOUSE, SAN FRANCISCO, OCTOBER 21, 1868.

made of shingles or sheet-iron, the whole resting on a quantity of small cast-iron balls carried on flat plates bedded in the foundations. The chimneys might be made of sheet-iron, carried through holes free of the roof. The ornamentation ought to be of light materials. The nature of the ground on which the house is built does not always

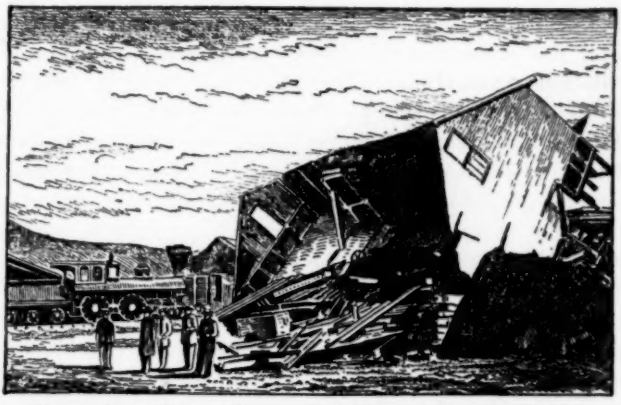


FIG. 8.—STUD MILL AT HAYWARDS, CALIFORNIA, OCTOBER 21, 1868.

appear to be in itself a matter of prime moment. Its relations with other foundations are more important. In some places solid strata, in others soft strata, appear to afford the more favorable situations; and the superiority of either probably depends on a variety of local circumstances. Places near the junction of the two kinds of forma-

tions are the worst. The progress of the wave may be interrupted by the interposition of a mountain-range or a hill, in which case we have behind the barrier the phenomenon called an earthquake-shadow; it may be cut off by a deep ditch, as a canal; and in certain parts of South America there appear to exist tracts of ground which are practically exempt from the shocks, while the whole country around is violently shaken. It would seem as if the shock passed beneath such a district as water passes beneath a bridge; and for this reason such tracts have been christened "bridges." In the Syrian earthquake of 1837, neighboring villages, and even neighboring houses, suffered differently. In one case a house was entirely destroyed, while in the next house nothing was felt. In Japan, at a place called Choshi, about fifty-five miles east of the capital, earthquakes are seldom felt, although the surrounding districts may be severely shaken. At this place a large basaltic boss rises in the midst of alluvial strata. The immunity of the district from earthquakes has probably given rise to the myth of the Kanam rock, which is a stone supposed to rest upon the head of a monstrous cat-fish, whose writhings cause the shakings so often felt.

Possibly something may be done in arranging the surroundings of buildings to ward off the destructive effects of earthquakes. The Temple of Diana, at Ephesus, was built on the edge of a marsh for this object. Pliny says that the Capitol of Rome was saved by the Catacombs. Elisée Reclus says that the Romans and Hellenes found out that caverns, wells, and quarries retarded the disturbance of the earth, and protected edifices in their neighborhood. The Tower of Capua was saved by its numerous wells. Vivenzis asserts that in building the Capitol the Romans sank wells to weaken the effects of terrestrial oscillations; and Humboldt relates the same of the inhabitants of San Domingo. Quito is said to receive protection from the numerous cañons in the neighborhood, while Lactacunga, fifteen miles distant, has often been destroyed. Similarly, it is extremely probable that many portions of Tokio have from time to time been protected more or less from the severe shocks of earthquakes by the numerous moats and deep canals which intersect the city.

Various causes have been assigned for the production of earthquakes, and, although they may all singly or in combination contribute to the effect, we must conclude, after considering the whole subject, that the primary cause is endogenous to our earth, and that exogenous causes, like the attraction of the sun and moon, and barometric fluctuations, play but a small part in the actual production of the phenomena, their greatest effect being to cause a slight preponderance in the number of earthquakes at particular seasons. The majority of earthquakes are due to explosive efforts at volcanic foci. The greater number of these explosions take place beneath the sea, and are probably due to the admission of water through fissures to the heated rocks

beneath. A smaller number of earthquakes originate at actual volcanoes. Some earthquakes are produced by the sudden fracture of rocky strata or the production of faults. This may be attributable to stresses brought about by elevatory pressure. Lastly, we have earthquakes due to the collapse of underground excavations ; and these may have been produced by evisceration caused by volcanic eruptions, by the washing away or solution of the earth by chemically charged waters or hot springs, or by other causes.

Considerable attention has been drawn lately toward the study of small vibratory motions of the ground which, to the unaided senses, are usually passed by without recognition. They are called earth-tremors, and were only discovered when difficulties caused by them were encountered in the adjustment of extremely delicate astronomical and other instruments. These movements have been most carefully studied in Italy by Father Bertelli, of Florence ; le Conte Malvasia, at Bologna ; M. di Rossi, at Rome ; and le Baron Puet, at Nice. Delicate instruments have been devised for detecting and recording them, the most important of which is the *normal tromometer* of Bertelli and Rossi. It consists of a pendulum (Fig. 9) one and a half metre long, carrying, by means of a very fine wire, a weight of one hundred grammes. To the base of the bob a vertical stile is attached, and the whole is inclosed in a tube, terminated at its base by a glass prism of such a form that, when looked through horizontally, the motion of the stile can be seen in all azimuths. In front of this prism a microscope is placed. Inside the microscope is a micromatic scale, so arranged that it can be turned to coincide with the apparent direction of oscillation of the point of the stile. In this way not only can the amplitude of the motion of the stile be measured, but also its azimuth. The extent of vertical motion is measured by the up-and-down motion of the stile due to the elasticity of the supporting wire.

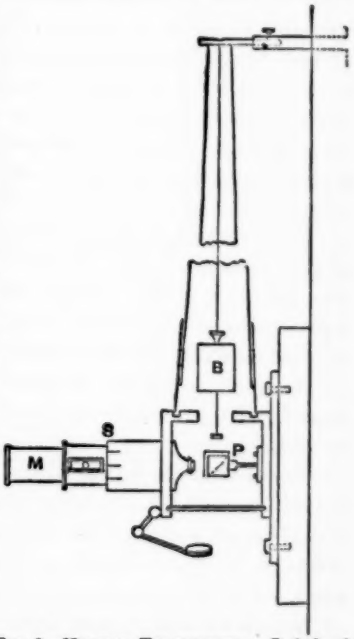


FIG. 9.—NORMAL TROMOMETER. B, bob of pendulum ; P, prism ; M, microscope ; S, rim of scale.

Another instrument, the *microseismograph* of Professor Rossi, gives automatic records of slight motions. It consists of four pendulums, each about three feet long, suspended so that they form the corners of a square platform. In the center of this platform a fifth but rather

longer pendulum is suspended. The four pendulums are each connected just above their bobs to the central pendulum with loose silk threads. Fixed to the center of each of these threads, and held vertically by a light spring, is a needle, so adjusted that each thread is depressed to form an obtuse angle of about 155°. These needles form the terminals of an electric circuit, the other termination of which is a small cup of mercury placed just below the lower end of the needle. By a horizontal swing of one of the pendulums this arrangement causes the needle to move vertically, but with a slightly multiplied amplitude. By this motion the needle comes in contact with the mercury, and an electro-magnet with a lever and pencil is caused to make a mark on a band moved by clock-work. The five pendulums being of different lengths, the apparatus is adapted to respond to seismic waves of different velocities.

Professor Rossi's *microphone* consists of a metallic swing arranged like the beam of a balance. By means of a movable weight at one end of the beam, this is so adjusted that it falls down until it comes in contact with a metallic stop. The beam and the stop form two poles of an electric circuit, in which is a telephone. The slightest motion in a vertical direction causes a fluctuation in the current passing between the stop and the beam, and announces itself in the telephone.

By observations made with instruments like these, it has been shown that the soil of Italy is in incessant movement, with periods of excessive activity, called seismic storms, that usually last about ten days. The storms are separated by periods of relative calm. They are more regular in winter, and exhibit sharp maximums in spring and autumn. In the midst of such a period or at its end there is usually an earthquake. They have been observed to be generally related to barometric depressions.

Earth-pulsations are slow but large undulations that appear to travel over or disturb the surface of the globe. They are made manifest through variations in the movement of pendulums, changes in the position of the bubbles of levels, eccentricities in the behavior of clocks, the swinging of chandeliers in churches, unusual disturbances in bodies of water, and even of water in tubs, irregularities in the flow of springs, and other phenomena, the occurrence of which, or the peculiar manner of it, while it is consistent with the hypothesis of such movement, can not be accounted for on any other probable supposition.

AN EXPERIMENT IN SILK-CULTURE.

By MARGARETTE W. BROOKS.

IN an article on silk-culture, published in "Harper's Magazine" more than a quarter of a century ago, the following passage occurs: "We shall soon be ready to begin that which the next century will find us doing with all our might—commanding the silk as we now do the cotton markets of the world." When we consider how little has been accomplished since that time, it is to be feared that this prophecy will not be realized unless greater advances are made in the next twenty-five years than were made in the last. Repeated trials seem only to show that silk-raising in the United States is not as profitable an industry as it was formerly thought to be.

The culture of silk is so old that we can not tell when it was begun, or by whom it was first discovered. The Chinese claim that it was known to them as early as 2600 B. C. Almost all Roman and Greek authors mention it, but it was probably unknown in Europe until the sixth century after Christ, and not until the sixteenth century was it successfully started in France.

In the year 1714 the manufacture of silk was begun in England. James I tried to establish it in Virginia; and in Georgia in 1732 lands were granted on condition that on every ten acres of cleared land one hundred white mulberry-trees should be planted, and, on the seal of that State, silk-worms in various stages of their growth were represented. Two or three years later the first export, consisting of eight pounds of raw silk, was sent to England, and the silk manufactured from it was presented to the Queen. In the year 1759 ten thousand pounds were exported, but after the introduction of cotton the culture of silk declined, and the last exportation from Georgia was made in 1790.

In the year 1771 Pennsylvania and New Jersey began the culture of silk, and experiments were also tried in New York and other States. In an old newspaper, under the date of 1786, we read, "Late Philadelphia papers mention, as an extraordinary circumstance, that a family in Maryland have upward of two thousand silk-worms at work."

The Revolution put an end to silk-raising for a time, but in the early part of this century the culture of silk was again started in a number of States, among others in Louisiana and South Carolina, and even before this one of our New England States—Connecticut—began the culture of silk. In the year 1790 it was said that fifty families in New Haven were raising silk, and in a newspaper for the year 1787 we read that "a young miss in New Haven will soon wear a silk gown of her own make." In the same paragraph the hope is expressed that

soon it may be "esteemed disreputable, by both ladies and gentlemen, to wear any thick silk but of our own manufacture."

In 1819 five tons of raw silk were raised at Mansfield, Connecticut, and the manufacture of silk is still carried on there. In the year 1835 we read of a company formed in Rhode Island having a large plantation of about thirty thousand mulberry-trees, and the State Legislature of that year offers a premium of fifty cents on every pound of silk raised and reeled in that State within two years from the passage of the act. "Rhode Island is likely," so the paper says, "to take the lead in the manufacture of silk as she did in cotton.

That the interest in the culture of silk must have been kept up, for a time at least, is shown by the fact that in 1840 the United States exported 61,552 pounds of raw silk, and in 1844 396,790 pounds, but in 1850 only 14,763 pounds were exported, while in 1870 the census gives no statistics of silk raised in this country.

About 1860 the culture of silk was started in California, where the conditions of climate seemed specially favorable for its success, and for some years it was carried on; but by 1878 it had greatly declined, owing possibly to commercial and industrial depression. Whether the industry continues to any extent we have not ascertained.

In the year 1882 the Department of Agriculture received many letters from persons interested in the culture of silk, and distributed a few silk-worm eggs, but there was no general distribution.

In 1884 the department appropriated fifteen thousand dollars for the encouragement of the industry, and a special agent was appointed to attend to the work, the department offering to send eggs to any one who would try the experiment of raising them. I should judge, however, that no very favorable reports were received, as, at a meeting of the American Association for the Advancement of Science, in 1885, as reported in "Science," Professor Riley stated that the culture of silk had been tried in the United States for fifty years, and all that the experiments had shown so far was that silk could be raised over three fourths of the United States if there was a market for the cocoons. He considers the industry best conducted on a small scale, and adapted for women and children who have no other way of earning money. The profit for three persons he estimates at fifteen to twenty-five dollars for the season, provided the cocoons bring one dollar a pound—a price, by-the-way, which only the best cocoons bring.

The care of silk-worms is decidedly wearisome, interesting though it may be; and certainly any woman enterprising enough to start in the experiment of raising silk, and strong enough to do the necessary work, might find some more profitable way of utilizing her time.

Mr. Edward Atkinson, at the same meeting of the Association above mentioned, maintained that the culture of silk in the United States was not desirable, since there was no lack of employment, as the high rate of wages shows, and we can not afford to do for our-

selves what foreign laborers will do cheaper ; and, moreover, the raising of silk has always been carried on by the poorest and most inefficient peoples, who, as they rise in the social scale, abandon it, as is now coming to be the case in Southern France—France being unable to compete with the cheap labor of China and Japan. It may be added that another reason for the decline of silk-culture in France is said to be due to climatic changes.

One spring my attention was called to an article on silk-culture in which it was stated that silk could be successfully and profitably raised in the United States. The article then went on to quote from a manual written by a young girl, who had tried silk-raising and had been very successful. By a strange coincidence, in a few days a friend offered me an ounce of silk-worm eggs which she had just received from the Department of Agriculture at Washington. Not having the time, and possibly the inclination, to raise the worms herself, she kindly gave them to me, and I determined to try the experiment of raising silk-worms in one of the New England States.

During three or four months of cold weather the eggs were kept in a cool place in a cellar, at as even a temperature as was practicable, the thermometer rarely, if ever, going below freezing-point, and never rising above forty degrees.

The mulberry-tree, upon which the worm feeds, is one of the last trees to leave out in the spring ; but soon after the 1st of June the leaves began to show themselves, and on the 11th of June the eggs were placed in a warm room, where, on the 13th, they had begun to hatch. Only a few worms appeared that day ; the two following days there were more, and on the 16th and 17th great numbers appeared. It is estimated that there are forty thousand eggs in an ounce, but only between two and three thousand of my lot hatched. However, a number of the eggs had been given away, and probably some were unfertilized, or had been killed.

Then began the task of keeping the worms supplied with food ; and, fortunately, I had found a friend willing to undertake the experiment with me, for a task it indeed proved. The white mulberry is not common in Salem, and the nearest tree was nearly one quarter of a mile from the house, and often we went a greater distance for the leaves. At first a small number of leaves were sufficient, but in a week or two my friend and myself had all we could do to keep the worms, which were growing rapidly, supplied with fresh leaves ; then, too, the lower branches of the tree, which was a large one, were soon stripped, and some one had to climb the tree for us. Fresh leaves had to be picked every day, sometimes twice and even three times a day. This in itself took some time, and, if the leaves were at all damp, they had to be wiped or dried in some way before filling the trays.

The trays in which the worms were kept had to be very carefully cleaned, and all the refuse removed every day. As the worms grew

larger they, of course, needed more space, and our room was gradually filling with extemporized tables and shelves covered with trays. The cleaning of one tray seems a small matter, but when there are over fifty trays to clean and fill with fresh leaves it takes a good while, and often we did not get to bed until midnight. As early as possible in the morning we were again at work feeding the worms, and for thirty days we were kept incessantly employed, oftentimes feeling discouraged, as the leaves were hard to get and the weather hot and debilitating. Still, we were determined to do the best we could, and so persevered in our self-imposed task.

Thirty days from the time of hatching, having lost no worms by disease, the spinning of the first cocoon was begun, and a relief it was to see a large worm crawling restlessly around the edge of the box leaving traces of silk in the corners. Two days later the worms were spinning in earnest, and we found our work of feeding and cleaning somewhat lessened. We tied together twigs and straw, upon which the worms made their cocoons. Following a friend's suggestion, we begged from a grocer some of the straw coverings of wine-bottles, and these the worms seemed to like very much. The room now presented a very different appearance from that which it had a week or two before. Instead of the rows of boxes, the tables were covered with straw tent-like arrangements upon which were the yellow cocoons.

Before all had finished spinning, we thought it time to steam a part of the cocoons, and here we met with our first difficulty. None of the books on the subject, which we had at our disposal, gave any very definite ideas as to the method by which this part of the work might be accomplished.

Finally, after considerable perplexity, we made arrangements to have the steaming done at a boiler-room. We laid about eight hundred of the cocoons on a layer of cloth netting in a large box, at one end of which a hole had been made and a round gas-tube inserted. To this tube was attached a pipe from the boiler, and for twenty minutes, the time specified in a report published by the Department of Agriculture, the steam was allowed to enter the box. At the end of that time we found to our dismay that many of the cocoons had been blown to one end of the box, forming a sticky mass. If we had been almost discouraged before, we certainly were discouraged now. However, we dried them in the sun, and a few were sent to the Woman's Silk-Culture Association in Philadelphia, with a letter, asking whether we had steamed them too much, and for information in regard to steaming the rest, of which we also inclosed a sample. In answer to our request, a printed circular containing general directions was sent to us, but no special directions as to steaming the others; but we were informed that our worms had been insufficiently fed; the cocoons were small, and steamed too much; and the fresh cocoons could not be reeled.

As there is but little market for cocoons in this country, all attempts to reel the silk here having been unsuccessful, we had not expected to realize much from the sale of the cocoons, still to be told that they were absolutely worthless was rather disappointing after our six weeks of hard work. We decided, however, to have the rest of the cocoons steamed, and these we did ourselves in a common steamer, and very much nicer they looked than our first lot.

But what was meant by our worms being insufficiently fed was not understood, and again we applied to the Woman's Silk-Culture Association for information, and this time we received a more satisfactory answer, though it seemed that our worms, instead of being underfed, may have been overfed, for the letter said they must not be fed while molting, and our worms had been fed at these periods. The "Report" gave the same information, but we understood the reason to be simply that time might be saved if worms of the same age could be made to molt together. But we found it difficult and well-nigh impossible to make them all molt at the same time, so finally were compelled to give them leaves as usual, supposing that those worms molting would not eat unless they needed food. In everything else we followed the directions given in the "Report" as nearly as possible. The worms certainly had plenty of room, fresh air, a uniform temperature, and as to the last requisite mentioned in the book—namely, cleanliness—we are sure that that condition at least was rigidly complied with, the trays being cleaned every day, and sometimes even oftener if it seemed necessary.

The room in which the worms were kept was on the northern side of the house, and had one northern and one eastern window, and a fireplace in which a fire was made whenever the weather was a little cool or damp, so it was comparatively easy to regulate the temperature.

In the second letter received from the Woman's Silk-Culture Association we were told that no one could expect to make anything from silk-raising until after two or three years' experience, and yet many papers speak of silk-raising as an employment, perhaps not very profitable, still a light employment for children and old people who can earn money in no other way. For farmers' wives this industry is also recommended, though where the ordinary farmer's wife is going to find the time for the business, coming as it does in the middle of the summer, when her work is heaviest, is not explained. One would think that any woman who could take care of silk-worms might earn more money in the same time raising chickens, selling eggs, or in light gardening, than by the sale of cocoons. Of course, like everything else, it requires skill and more especially experience, but there are few light employments that would not bring in a little money even the first year. To be sure, the outlay in the beginning is small; but had our cocoons been the ordinary size, and suitable for reeling, we could not, at the price cocoons are now bringing, have received more than

five dollars to pay us for the time spent in taking care of the worms during six weeks of intensely hot weather. Our expenses, not counting the cost of the fuel burned, amounted to over one dollar and fifty cents.

That others have had somewhat similar experiences is shown by the following extracts from recent newspapers. From Springfield, Massachusetts, a lady writes that, although she had but about eight hundred silk-worms, they kept her very busy during the last molt picking leaves, and she should not advise any one to engage in the business unless one is willing to work, for it is not an employment for lazy people. In return for her cocoons, which she sent to the New York Silk Exchange, she received a silk handkerchief and some embroidery floss made from her own cocoons, valued at about one dollar and twenty-five cents, which she thought "poor pay for six weeks' work." Her expenses, not counting time and labor, amounted to one dollar and sixty-three cents.

A widow in Ohio thought that the culture of silk might prove a pleasant and profitable way of supporting herself and two children; but after some expense and "six weeks of hard work, Sundays and all, found that she had not made a dollar by the operation."

From the "Massachusetts Plowman" the following extract is quoted: "Silk-culture requires a very close, unremitting attention on the part of those engaged in it, and if the work is not laborious it is so constant as to prevent the following of any other occupation at the same time. Those who desire to engage in sericulture will do well to consider thoroughly the matter."

One thing I can say in regard to the experiment, it is interesting work, though, whether it would be so to a person not interested at the outset in such matters I can not say; and, besides, it keeps one so busy that the interesting points are often overlooked. Yet I am sure that numerous friends who saw the worms in their different stages thoroughly enjoyed them, and it was of some account certainly to have interested so many people in a subject of so much importance. How many children, and I may say older people as well, never knew before that a moth came from a caterpillar, or that a worm formed the cocoon from which all our silk is made!

THE INFLUENCE OF EXERCISE UPON HEALTH.

By Professor EUGENE L. RICHARDS,
of Yale College.

MANY old theories of education are being mercilessly discussed. Many new theories claim the places of the old. The classical scholar still claims for the ancient languages the greatest educational power. The advocate of modern languages says life is too short to

study dead things, and that modern languages furnish enough discipline, and are, besides, useful. To the scientist, science is god of all, even of education. To him no man is properly educated unless his mind is stored with scientific ideas and trained by the scientific methods of the nineteenth century. Languages, ancient and modern, mathematics, science, philosophy, all advance their claims to be the best educators of the coming man. Meanwhile the coming man is nothing but a child, and must submit himself to his elders to be experimented upon according to the theories of teachers or parents.

For men, women, and children alike, I wish to enter a plea for a part of them much neglected in most discussions on education, and too much left out of sight in most theories of education—the body. In fact, for centuries past, many educators have seemed to regard the body as a rival of the brain, if not an enemy of it. They have apparently been filled with the idea that strength and time given to the body are strength and time taken from the mind. Unfortunately for the cause of good education, this erroneous idea is not held by teachers alone, but is a very prevalent one generally, the current dictum being that, representing by unity a person's force, whatever part of this unit is taken for the body leaves necessarily just that much less for the mind.

To combat this idea, and to replace it by a much more reasonable idea, I had almost said by the *very opposite idea*, shall be the chief though not the only aim of these pages.

To all races which have shown power in any direction the main source of that power has been physical. This is acknowledged to be true with regard to the conquering races of the past. With regard to the present we are too apt to think that the progress of civilization has changed the conditions of power, so that races physically weak, if they are only wise, can successfully compete with and finally overcome the strong races.

Take the Greeks. For a long time they were a conquering race—masters of the world of their time. But their influence has extended far beyond their day and beyond the limits of their little world. "It is no disgrace to a nineteenth-century American to go to school to the Greeks. They are still, in their own lines, the leaders of mankind. They are the masters." "Attica was about as large as Rhode Island. Rhode Island is a noble little Commonwealth. Yet it has enjoyed political liberty longer than the democracy of Athens lasted, and in the midst of the blazing light of this much-lauded century. What now is or will be the influence of Rhode Island on the world's history compared with the unmeasured and imperishable influence of Athens? Whence the difference?" * The causes of the difference were manifold. One cause was their physical education. Hand in hand with their mental discipline, which was simple but thorough, went gymnastic exercise. "Until the time of Alexander, the main

* Professor George P. Fisher, "Princeton Review," March, 1884.

subjects of education among the Greeks were music and gymnastics, bodily training and mental culture. . . . The first duty of a Greek boy was to learn his letters, a feat which was also coincident with learning to swim. . . . By the fourteenth year the Greek boy would have begun to devote himself seriously to athletics."* Could such a careful and continuous training of the body fail to have its effects upon the mind? It gave the body power. It gave the brain force. Had this force not been converted all the while into intellect and æsthetic sense, the Greeks would have formed a race of fine animals only. But their mental discipline saved them. Unfortunately for the permanence of the Greek power, that power was not built upon a moral basis. When, by means of their conquests, wealth and luxury came to them, the Greeks met the usual fate of nations weak in the moral sense. Their discipline was relaxed, and they succumbed to the strong.

The training of the Romans was largely physical. They were trained for war. But they, too, were overcome by stronger races when they relaxed their own discipline and gave up their martial games and athletic exercises — hiring gladiators for their sport and mercenaries for their battles.

What are the conquering races of to-day? Are they not the nations strong in body—strong by inheritance and keeping their strength by exercise? Germany keeps her men strong in the army by compulsory gymnastic drill. Her schools teach gymnastics. Many of her inhabitants in the cities maintain their strength by the exercise which they have in their excellent Turner system.

England has in the bodies of her children the blood of those old rovers who were the terror of the coasts of Europe in the early centuries of the Christian era, mixed with the blood of that vigorous native stock, to subdue which, even when furnished with only barbarian arms, was no easy task to the Roman legions with all their military skill. In England, too, this physical force is still maintained by vigorous exercise taken by all classes. The higher classes have their out-of-door sports, and some of them of the roughest kind. The lower classes also have their sports. Wherever the English race goes it carries with it the love of exercise and the practice of it. Even their women engage in it. Some of them follow the hounds. They pull the bow. They take walks, the length of which would shame many an American man. So the vigor of the stock never decays. The race increases and multiplies. The little island can not hold it. Away it goes to conquer and colonize the globe, and to infuse its strength into all the races of the earth.

What keeps us as a nation from deterioration? The bone and sinew of the land—the cultivators of the soil—the conquerors of our new land —the men who build our cities and the great highways between them, who dig our coal and labor with hand and body in all our factories.

* "Educational Theories," by Oscar Browning.

It is true that brain directs all this activity, but muscle is the motive-power. And the muscle of one generation is the source and support of the brain-power of the following generations. "What else accounts for the prodigal activity" * of the descendants of the early settlers of this country, but the fact that obliged, when cast on a land like ours, to battle with the elements and conquer the forests by their own bodily strength, they lived an out-door life in the main, and stored up an immense "capital of vitality" which they handed down to their posterity? Some of that posterity are not content to use the interest of that capital, but are spending the principal. What is the consequence? Not only enfeeblement of body and mind, but sterility; and thus, many of the old New England families are dying out in the homes of their race, and are giving place to the strong new-comers.

As to individuals, what kinds of men fight their way to the front ranks in all callings, and hold their places there, as men eminent in their day and generation? Men of strong body. Consider the premiers of England—men like Brougham, Palmerston, and Gladstone—working at an age when many a weaker man would either be in his grave or be preparing for it! Some exercise—horseback-riding or felling trees—keeps up their strength long after threescore and ten. It is only necessary to mention Washington, Jackson, Webster, and Lincoln, to call attention to the fact that among eminent American public men vigor of mind and vigor of body go together. Notice the great pulpit orators of to-day—such as Spurgeon, Beecher, John Hall, and Phillips Brooks. Among moneyed men, did not Commodore Vanderbilt owe something of his vast fortune to his strong body? Could he have endured the strain of building that fortune, and would he have had the vigor to extend it, had it not been for the out-door life of his early manhood? If you find a really successful man, who builds and keeps either a reputation or a fortune by honest hand work, he is generally a man of vigorous body. "All professional biography teaches that to win lasting distinction in sedentary in-door occupations, which task the brain and nervous system, extraordinary toughness of body must accompany extraordinary mental power." † Again, "To attain success and length of service in any of the learned professions, including that of teaching, a vigorous body is well-nigh essential." ‡

It would be out of place to advise a farmer who is already tired of digging and plowing, or a mason who has had enough of bricklaying, to exercise his body. A little play to limber the stiffened muscles might be a good thing. A little brain-work might be better. But of real hard-working exercise of body each working-man gets enough from his day's labor. If he only get good food and enough of it, and have time for sufficient sleep, and get pure air to breathe, and clean water to drink and to bathe in, he will do well enough, as far as bod-

* S. Weir Mitchell, in "Wear and Tear."

† President Eliot, in "Annual Report for 1877–'78."

‡ President Eliot.

ily health is concerned. But to brain-workers and to all persons of sedentary habits it can be truly said that vigorous exercise of the entire body is not only advisable if they would enjoy health, but that it is absolutely essential to that life. The London "Times," of December 11, 1882, records the physical and mental deterioration which has fallen on the civil servants of India, described by an Indian correspondent: "Since the institution of competitive examinations, out of a hundred-odd civilians nine have died and two have been forced to retire on account of physical debility. Ten more were considered quite unfit for their work on account of bodily weakness, and eight have positively become insane."* Here is a record of twenty-nine out of a hundred persons physically deficient. The hundred belonged to one of the strongest races of the earth. Does not the fact testify to the great demands of civilization on the vitality of the people of modern times? But it will be replied that the climate of India had something to do with the facts. Well, read what Dr. E. H. Clarke says of our country: "No race of human kind has yet obtained a permanent foothold upon this continent. Mounds at the West, vestiges in Florida, and traces elsewhere, proclaim at least two extinct races." "The Indian whom our ancestors confronted was losing his hold on the continent when the Mayflower anchored in Plymouth Bay, and is now also rapidly disappearing. It remains to be seen if the Anglo-Saxon race, which has ventured upon a continent that has proved the tomb of antecedent races, can be more fortunate than they in maintaining a permanent grasp upon this Western world. One thing, at least, is sure: it will fail, as previous races have failed, unless it can produce a physique and a brain capable of meeting successfully the demands that our climate and civilization make upon it."† Read the following facts with regard to Chicago: From 1852 to 1868, population increased 5·1 times what it was in the first peried. The death-rate increased 3·7 times. The deaths from *nervous* disorders increased 20·4 times.‡ Chicago is perhaps a fast place, but the figures are significant of the wear of city life on the nervous system.

Is not this strain of the nervous system a peculiarly American danger? To be sure, all brain-workers in all countries are liable to it, but in our country climatic influences increase the tendency. Under these influences we have developed national characteristics, showing in form and feature. We do things in a hurry. We are in haste to get rich. We are in haste to be wise. We have no time for exercise. We have no time for play. Both exercise and play are by serious people often looked upon as a waste of time for adults, however good they may be for children and young people. A boy must be a man before his time, and a girl must be prim and staid, and must not romp like her more

* Bonamy Price, in "Princeton Review," July, 1884.

† "The Building of a Brain," Dr. Edward H. Clarke.

‡ "Wear and Tear," Dr. S. Weir Mitchell.

fortunate brothers, but must be a sober woman after she has entered her teens. It seems as if the battle of modern life (at least of modern city life) was a battle of the nerves. "From nursery to school, from school to college, or to work, the strain of brain goes on, and strain of nerve—scholarships, examinations, speculations, promotions, excitements, stimulations, long hours of work, late hours of rest, jaded frames, weary brains, jarring nerves all intensified by the exigencies of our school and city life."* The worst of the mischief is, that this strain falls most of all upon those from nature and circumstance least able to bear it—upon our women. Public opinion frowns upon their exercising like men. Yet, with a nervous system more sensitive than man's, they need the very exercises (out-of-doors) which, by a mistaken public sentiment, they are often forbidden to take. The healthy house-work is often deputed to a servant either because too hard for our American girls, or too much beneath them.

Of the five agents of health—exercise, food, air, sleep, and bathing—exercise, to a certain extent, regulates the demand for the other agents. The muscles, when fully developed, constitute about a half of the full-grown body. The muscular contractions act upon the blood. The blood is the life-stream, carrying the atoms of nourishment to every part of the body, and receiving the waste particles which have already done their work. This process of depositing building substance and receiving waste matter goes on according to a law. This law, called, from its discoverer, the law of Treviranus, is—"Each organ is, to every other, as an excreting organ. In other words, to insure perfect health, every tissue, bone, nerve, tendon, or muscle, should take from the blood certain materials and return to it certain others. To do this, every organ must or ought to have its period of activity and rest, so as to keep the vital fluid in a proper state to nourish every other part."† So that, if we give to the muscles their share of labor, as indicated by the ratio which they bear to the whole body, according to this law, we ought to give a large proportion of our waking hours to their use. But there are certain involuntary muscles doing their work all the time, night and day. In our usual vocations, too, however confining they may be, we are obliged to take a certain amount of muscular exercise. Consequently, in the really necessary work of any ordinarily busy person, the muscles do have a fair share of exercise. Still, there are a number of muscles which are used almost exclusively, so that other muscles, with their connecting tendons, bones, and nerves, fail, from sheer neglect, to contribute to the health of the whole body. How many women exercise fully the large muscles of the back and loins, or the muscles of the abdomen? Women who wash, or those who work in field or garden. Yet these important muscles, when used, contribute much not only to the health of the body in general, but also to the vigor of the organs lying underneath

* "Physical Training," McLaren. † "Wear and Tear," S. Weir Mitchell.

them. So, too, in walking, how few use the muscles of the calf of the leg? Most people merely stamp along the path or road. They do not use the foot from heel to toe. They fail to rise on the toes at the end of the step, and do not push themselves along with those important members of the foot. Thus they lose the best part of the leverage of that important muscle or set of muscles of the lower leg. The fault is frequently in the shoe of the walker. That has too high a heel, and pinches the toes, making any movement of them painful, even if it does not prevent them from moving at all.

By making regular daily use of the muscles—of all the muscles, if that were possible—we should do one thing toward establishing perfect health of body by allowing to one very large part of it a fair chance to appropriate its proper elements from the blood, and opportunity to give back its used-up tissue to be eliminated from the system in natural and healthy ways. We should be doing more than simply repairing the muscles. We should be also evolving heat—a very important factor of life. We should be assisting all the other parts of our organization to do their work.

Take the heart—itself a very bundle of muscular fibers. We know that as long as we live, whether sleeping or waking, that wonderful organ keeps up its regular contractions and expansions. But, when we use our muscles, their contractile force upon the blood-vessels helps the blood along its channels, and thus takes a little labor from the propelling heart. It beats faster but with less effort.

While helping the heart, muscular exercise helps the lungs also. More exercise means for the lungs more breath; that is, more air inspired, and more carbonic-acid gas expired. By deeper breathings the involuntary muscles are strengthened. Moreover, we are made to feel the need of greater lung-room. Even after the age when full stature is supposed to be attained, that lung-room often comes, Nature furnishing the supply according to the demand. McLaren notes the case of one man, in his thirty-sixth year, whose chest, under systematic exercise, increased in girth from thirty-two to thirty-six and a half inches in *two* months. There was an addition of four and a half inches to the circumference of the chest. "An addition of *three* inches to circumference of chest implies that the lungs, instead of containing 250 cubic inches of air before their functional activity was exalted, are now capable of receiving 300 cubic inches into their cells."* This great increase, of four and a half inches, meant not only increase of lung-room, but increase of lung-power.

Taking the quantity of air inspired in the reclining position in a given time as the unit 1
In the same period of time the quantity of air inspired when standing is . . 1·33
When walking one mile per hour, is . . . . . 1·9
When walking four miles per hour, is 5
When riding and trotting, is . . . . . 4·05
When swimming, is . . . . . 4·33†

* "University Oars," Dr. Morgan. † "Health," Dr. Edward Smith.

While the lungs and heart are doing better work under the stimulus of muscular exercise, the heart pumping the blood more certainly to the farthermost tissue of the body and the lungs more rapidly purifying the blood, other organs are benefited. The diaphragm, that muscle separating the lungs and heart from the stomach and liver, is rising and falling, and, with the increased expansion and contraction of the walls of the thorax, is moving all the contents of the abdomen to activity. The liver, the great gland of the body, has not only more blood sent to it, but is quickened to action. For bilious people there is no medicine like exercise and fresh air. In malarial districts, bilious people are most easily affected by the malarial poison. Though in such districts a great many troubles are conveniently laid at the door of that enemy of health which do not justly belong there, yet of the fact that some are affected by it, and others equally exposed are not affected by it, may not the explanation be, that an active circulation in one person effects the elimination of the poison through the excretory organs so rapidly that it can not collect in sufficient quantities to cause disturbance of the system? In the case of a person affected by a stupefying poison, the first thing to be done is to keep the individual moving; that is, to keep the circulation going by exercise till the poison can be eliminated. The laboring-man who works at a sewer in front of a house seldom feels any ill effects from the overturned soil and poisonous gas, while some dweller in the house, apparently not so much exposed, is stricken with typhoid or malarial fever. Causes of the immunity of the workman may be found in his greater strength and feebler sensibility, and in his open-air life; but may not another reason be seen in the quickened action of his lungs and the profuse perspiration of his skin? As to the effect of want of exercise on the liver, the following passage may be quoted from an authority on the subject: "A want of exercise in the open air leads to derangement of the liver in two ways: viz. (*a*) By causing a deficient supply of oxygen to the system, as a result of which the oxidizing processes, which go on in the liver and elsewhere, are imperfectly performed, and there is a tendency to the accumulation in the system of fat and the imperfectly oxidized products of disintegrated albumen. Oxygen is, so to speak, the antidote for the destruction of *materies morbi* (lithic acid, etc.) produced by imperfectly oxidized albumen. (*b*) By retarding the circulation of the blood through the liver. Since the time of Haller (1764), physiologists have recognized the influence of the respiratory movements in producing the circulation of blood through the liver; but upward of thirty years ago Mr. Alexander Shaw showed more clearly than ever before that the circulation of blood through the liver was greatly influenced by the alternate expansion and contraction of the thorax during respiration. Mr. Shaw called attention to the fact that the portal vein, without any provision for increasing its power, 'has to perform

the duty usually fulfilled by an artery.' He suggested that this weak power, by which the portal vein propelled its blood, was compensated for by a suction force communicated to the current of the blood by the actions of respiration. These reasonings have been confirmed by certain experiments of M. Bernard." "In persons, then, who lead a sedentary life, this auxiliary force for promoting the circulation of blood through the liver is diminished, blood stagnates in the gland, and the functions of the organ are deranged, these results being all the more likely to arise if the liver be at the same time over-stimulated by errors in diet." *

Take another organ. The stomach is a muscular organ, being furnished with bands of muscular fiber, which squeeze and press the food, turning it over and over, so that it may be the better permeated by the juices which digest it. It, too, is stimulated by exercise, especially by an exercise like walking or riding, which increases its movement. This motion makes easier work for the organ and increases its activity. It increases its activity also in another way, by demanding more of it. For increased work by any part of the body means increased destruction of tissue. "To repair the waste is the office of the blood, as the distributor of the material to be supplied. The main furnisher of this new material in the right form to do its work is the stomach. For food is both the fuel which keeps our bodily machinery going and the material by which the machinery itself is repaired. The stomach, with the duodenum, is the place where all this material is prepared to do its work in the most economical way. More exercise, then, means more waste, more waste means more repair, and more repair means a greater demand for food and water. The more, then, we waste any part of the body by exercise (within certain limits), if there is due repair, the better off is that part. The strength of the body, as a whole, and of each part of the body individually, is thus ever in relation to its newness." †

The bowels, too, the great sewers of the bodily system, inclosed in pliable walls needing constant motion and fresh supplies of blood for their healthy exercise, feel the action of the breathing lungs, and are sensible of every turn, twist, rising, and falling of the body. Deprive the body of exercise, and you deprive the bowels of blood and proper action, and bring in a long train of evils, a catalogue of which can be read in the advertising columns of almost any daily newspaper.

The kidneys, too, are affected by physical exercise. Doubtless they receive a certain stimulation from the motion communicated to them in exercise, but as they are engaged in the work of eliminating from the system its excess of liquid with certain effete matter in solution, and as the skin is also concerned in a similar work, they are affected by exercise mostly with reference to this joint action. The more active the skin is, the less work the kidneys have to do.

* "Functional Derangements of the Liver," Murchison. † McLaren.

To realize more definitely the work which the skin does, consider the fact that a square inch of skin is calculated to contain twenty-eight thousand pores. These pores, if healthy, are at all times purifying the blood by insensible perspiration, and in times of vigorous exercise make that perspiration very sensible. This sensible perspiration is essential to health, for the pores must occasionally be opened wide and flushed, in order to cleanse them thoroughly. Not only is this action of the skin in exercise increased by the increased flow of blood to the surface, but also by the mere motion of the muscles under the skin. This last effect might be called the direct effect of exercise on the skin. How close this connection is between the skin and muscles may be seen from the fact that "any part of the skin of the hand is in connection with, perhaps, two hundred muscles." This "fact, showing the exceedingly numerous and complicated communications between a given portion of the skin and the moving organs," * makes it easy to conceive how the skin is stimulated to action directly by exercise.

Bodily exercise is essential to the healthy action of the brain and the nerves. There is no real conflict between brain-work and body-work. Brain presupposes body; can not exist without it; is dependent upon it for support and nourishment. Brain can not communicate with the external world, nor with other brains, so far as we know, except through the medium of the body. Consider how brain-power is formed and grows in a child. Is not the first exertion of mental power, as well as the first sign of life, connected with motion? Back of the child's outstretched hand there is in the mind a desire for something and a will to obtain it. Each consciously directed muscular action has two effects, one on the muscle used, another on the directing brain. Can there be any doubt that this mutual action of brain and body contributes to the growth of each? Can there be any further doubt that, the more organs which the brain supervises, and the more muscles which it controls and directs, the more opportunity the brain has for growth? "Brain is evolved from the organization." † First, there is "growth, the force for which was supplied from a hundred sources"; and, secondly, there is "a power grown. . . . No perfect brain ever crowns an imperfectly developed body." This, then, up to a certain time of life, is Nature's method of forming brain-power, viz., by the conscious activity of the bodily powers. The fact that most people are right-sided as well as right-handed is registered in their brains; the *left* side of the brain, which supervises the *right* side of the body, being generally the larger.

In this growth of the brain, the whole nervous system is involved. The spinal cord (almost a continuation of the brain), and every nerve, which from each organ brings intelligence of want, and every nerve that flashes the order to supply that want, all are brought into action

* Bain. † "Building of a Brain," Dr. Edward H. Clarke.

by exercise, and all are nourished by the circulating blood. Think of the immense strain upon the bodily powers to keep the brain and nervous system properly nourished! It is calculated that the brain alone requires one fifth of the entire supply of blood in the body. The drain upon the bodily vigor of a brain-worker would be greater than this fraction represents, if it were not for the law of Treviranus, according to which an organ not only takes from the blood certain materials, but also supplies to it other materials. "Just as, on a larger scale, the carbonic acid exhaled by animals is taken up by vegetables, and a poison thus removed from the atmosphere in which the animal lives, so by one organic element of the body the blood is purified from the waste matter of a higher element, which would be poisonous to it."* So that a tired brain and quivering nerves may not be more wearied by physical exercise, but may be refreshed by it. This refreshment may result from two processes: first, by withdrawing the excessive supply of blood from the before active organ; and, secondly, by purifying the blood so that it may be ready to properly nourish the brain. And the muscular system not only acts as a store-house of vitality for the brain, and a purifier of its supply of blood, but it covers the nervous system, acting as its stay and protection. "To be weak is to be miserable. . . . Susceptibility of nerve and feebleness of muscle generally go together." To correct one deficiency is usually to cure the other weakness.

To the young, physical exercise is essential to growth, both of body and mind. Youth is not only the time to cultivate good habits, but also the time to store up vitality. At that time many abnormal developments can be corrected by appropriate exercises. At that period, too, the healthy balance between brain and body can better be established. To children, exercise is specially needful for healthy nerves, since, as compared with the nervous system of an adult, the nervous system of a child is five times as large, in proportion to the size of the body. In them, therefore, "that parasite of the blood," the brain, demands that a greater amount of time should be given to waste and repair of tissue by means of exercise, and that a greater amount of proper food should furnish the supply of nourishment. Short intervals of study, long intervals of play or light work of body, and that in the open air, if possible, should be the rule for children. As they increase in years more time can be given to conscious cerebration. At some periods of growth, all the way from the age of twelve to eighteen, according to the individual, special watchfulness is required of parents and instructors to see that the functions of growing organs are not interfered with by excessive attention to brain-work. At this critical time no study would be safer than too much study.

After a good muscular system has been developed in childhood and youth, a comparatively small amount of time judiciously devoted to

* Maudsley.

exercise will keep a person in healthy working order till near the age of forty.

The age of forty to fifty is the period of life during which, according to the best authorities, the need of exercise is the greatest. "At no time of life is the necessity of exercise so imperative.* . . . At that time the circulation becomes defective, unless continually quickened by exercise"; there is a tendency to passive congestion and functional derangements of various organs, especially the liver. At this time, though needing less food, we are apt to eat more than in the periods of life immediately adjacent. Consequently, the products of disintegrated food and tissue are not eliminated. Accumulating in the blood, they form the *materies morbi*, the matter on which death feeds.

Tiding over the period of middle life, by using appropriate exercise, and by care to see that all the excretory organs do their proper work at proper times, we ought to find the following years the best years of life, especially for brain-work. If we lived rightly, the words of the poet ought to be true for us all:

> "Grow old along with me!
> The best is yet to be,
> The last of life for which the first was made;
> Our times are in his hand
> Who saith, 'A whole I planned,'
> Youth shows but half: trust God; see all, nor be afraid." †

As to kinds of exercise, each person must be thrown on his own judgment with regard to his own case. In McLaren's "Physical Education," and in Blaikie's "How to Get Strong and How to Stay So," most excellent hints will be found for all cases. In beginning a course of systematic exercise, it is wise to err on the side of doing too little rather than too much. Increase the amount of exercise very slowly. No discouragement should be felt if it is hard work at first. It will become easier and easier. It may be a long time before it can be taken joyfully, yet, if any person will persevere, he will be certain to rejoice in the work, and will come to feel that he can not do without it. There is no royal road to health any more than there is to learning. Like all things made precious and to be really enjoyed, health must be earned.

It may be said that, for all persons whose regular occupation is sedentary, exercise in the open air is to be preferred. The oxygen of the air is essential to the life of the blood. It is well also to take exercise as much as possible in company. One person encourages another. A man will often take part in exercise with a companion so as not to disappoint him, even if he would not exercise for his own sake. Hence one valuable feature of games or athletic sports. They must be carried on in company and by system. Another valuable feature of games

* "Exercise and Training," Ralfe. † "Rabbi Ben Ezra," Robert Browning.

and sports is that in them the mind is occupied without being taxed. It is diverted from its usual cares. The sports are well called recreative. Both body and mind are recreated by them.

To affect the chest and the underlying organs, such as lungs and heart, the most direct means lies in exercise of the muscles of the arms and shoulders. If a person has weak lungs, one of the first objects at which he should aim should be the strengthening the muscular system covering the chest. If such a person is weak, let him begin exercise very cautiously, and increase very slowly the duration, frequency, and difficulty of his exercises until he is made to breathe hard. In taking a full inspiration, not only are the lungs affected, but, strange as it may seem, the brain and spine also. "The fluid surrounding the brain and spinal cord is essential to their safety. The motions dependent on the action of the heart are much weaker on the spinal cord than on the brain, while those connected with breathing are more constant and considerable on the former, from the more powerful distention of the veins of the spinal canal. . . . The fluid surrounding brain and spine regulates their vascular fullness," and "it is manifest that, in order to keep up the proper alternations between the brain and spinal cord, and between the heart and lungs, it is not enough to breathe pure air, but it is also necessary that it should be *deeply* breathed." *

The effect of exercise on the character is felt most of all on the will. This is very natural, for in all muscular exercise a certain amount of resistance has to be overcome, and the power which acts through the muscles to overcome this resistance is will-power. Development of muscular strength is, therefore, to a certain extent development of will. It becomes development of the highest kind of will, that of self-mastery—when to take exercise a man resolutely overcomes the distaste for it. This feeling often comes upon us, when we are weary with brain-work and are inclined to rest, and to forego exercise. But let any man resist the temptation and take the exercise, and he will find that the brain is rested and refreshed, and the whole body renewed and invigorated.

It is not true that so much given to body is just so much taken from brain. It has been the aim of the writer to show that all parts of the body, the brain and the nervous system among the rest, contribute to the vigor of the whole; that the muscular system forms about half of the body, and is a very important contributor to the health of all the organs. Body and brain are parts of a harmonious whole. Either neglected makes trouble for the other. Each appropriately exercised means not only health and strength to that one, but vigor to both. This hue and cry against exercise and sport, as being detrimental to mental culture, is founded on a mistaken theory that the material and spiritual parts of a man are enemies—so much less material, so much more spiritual. But it ought to be observed that a

* Dr. George Moore.

very high authority says it is the "carnal *mind* which is enmity against God," and "out of the *heart* proceed evil thoughts, murders, adulteries." Man is not more of a "brute" for cultivating his body, but a better man if he cultivate both body and mind: body, first in the order of development; mind, second in order of time, but the crown and king of the whole.

TRANSPORTATION AND THE FEDERAL GOVERNMENT.

By JOHN C. WELCH.

MOST of the great fortunes of the United States—those that are unduly great—are ascribed to the rapid development of the means of transportation and the facility with which those means have been centered in comparatively few hands. The general sense of the nation is that this concentration of power, of wealth, is an evil, and that it would be much better if we could have had the development of the transportation interests that we have had with a greater diffusion of the power and wealth that have attended them. The founders of our republic thought they were establishing civil institutions where enormous fortunes would be comparatively unknown. A hundred years have hardly passed—certainly not a long time in national life—when the largest individual fortune of the world is accredited to the United States, and there are others that approximate this in magnitude, and many of them dating back to less than one fifth of a century. In the matter of private wealth, we have clearly departed from the ideas of our fathers. In this departure is there adherence to the stern principles of republicanism with which our country started out, and have these growths been fortuitous, exceptional, easily swallowed up in the general growth and prosperity of the country, so that the spirit of our institutions is unchanged, and are these fortunes to be dissipated in an early succeeding generation, and not to be replaced by others of equal or greater magnitude and greater in number? The instincts of the nation are that danger lurks in any other solution of these inquiries than in the line of suppression of causes that have made these fortunes possible. Nor can the subject be dismissed on the ground that, in the development of the use of the physical forces of steam and electricity that this generation has seen, there is inherent this aggregation of wealth in few hands. The disproof of this is that in European countries that have enjoyed a like favorable development with ourselves in wealth, barring that which came from our virgin territory, such developments of the physical forces in their administration and the accompanying emoluments have not been centralized upon a few.

These administrative emoluments, in the case of railroads, accruing to so few, may be briefly summarized as follows:

1. The gratuitous distribution of stock to promoters and the construction of the railroad from the sale of mortgage bonds, and by defaulted bills for merchandise and labor.

2. Construction boards, corporations, committees, directors, made up of promoters who handle the cash realized from the sale of bonds and the credit which has been established for the property, and who are practically irresponsible, as they report from themselves as constructors to themselves as proprietary directors.

3. Express and other companies making use of the franchises of the original company and its road-bed, and taking to themselves the cream of the business.

4. Rebates, drawbacks, and the various devices by which favored shippers are allowed to usurp the business of the road, or the bulk of it, in certain channels, and in which the profit accruing to them from paying less freight is directly but the minimum advantage to them, as by it they may control the production, manufacture, and marketing, and real and speculative prices of an important commodity, and so, by eliminating competition and controlling speculation, draw enormous profits from the public that do not show at all in the simple handling of the articles as freight.

5. The property being corporate, and its ownership represented by negotiable stocks and bonds, and which have gone largely into the hands of the public, both by the natural and manipulated fluctuations which take place in the negotiable securities, those that are "outside" are at immense disadvantage compared to those that are "inside," and a perennial source of profit is at hand for the "few" who have reached the advantageous positions. By possessing inside knowledge of a number of leading companies, by making money in the loan market scarce or plentiful, the whole stock market can be "raided" for the benefit of one or more operators.

6. The wrecking, intentional or otherwise, of valuable property through accumulated mortgages and debts, and its re-establishment at a comparatively small cost to the new owners.

7. The consolidation of different companies: those that are continuous on the same lines; those that are parallel, and originally designed to be competitive, and those that radiate from a common center or do the business of a particular section. To make one company of two or more companies, to economize in administration, to make them probably more effective, to eliminate competition, has been generally unlooked for, and has added greatly to the economic position, and consequently to the value of the railroads as paying properties. While the consolidation may be meritorious, this has afforded the chief opportunity for "stock-watering," and is a field where Napoleons of finance have specially distinguished themselves and enhanced their wealth.

8. The large salaries paid high railroad officials is to a great degree only a legalized method of giving them an important part of the emoluments received. Their positions being free from the strain of personal competition and risk of capital, such as attend the business man, and without the pressure of social expenses and duties, such as rest upon the high government official, and frequently destitute of requirements of expert skill and professional knowledge, such as often command prizes of the highest kind, they are altogether without a parallel as remunerated positions.

Electric, gas, and other companies represent branches of transportation, of which railroads are the great representatives, and much is true of these companies that is true of railroad companies, and all stand on much the same ground regarding salaries paid to their high officials and in their general effects.

In contrast to these advantages accruing to railroad organizers and managers, the advantages that are supposed to accrue by the organization of railroad and all other stock companies, and to which prospectuses however flattering, are confined, are—

1. The profit on the investment through rise in the value of the property, and dividends to those who give valuable considerations for stocks and bonds.

2. The indirect benefit that will accrue to other properties, and the public convenience and advantage that will be derived from the operations of the company.

Where legitimacy begins and where it ends in such organization and management is a question of casuistry in particular cases, but there has been swerving enough from what is legitimate to make it the startling and pronounced feature of American commercial life for the past twenty-five years.

As the result of such illegitimacy, as the leading cause, what do we find?

We find Pelion piled on Ossa in the matter of private wealth.

We find the ideas of equality and simplicity on which the Government was founded stultified in the house of their friends.

We find fiery zeal and many successes in making millions and multiples of millions, and the hardships of acquiring a competence, increasing.

We find a class that exceed any class of officers in the Government in the importance of tenure and their power—*imperium in imperio.*

We find the individual less assertive than a generation ago of his independence, and the typical, prosperous citizen eats the bread of dependence upon a corporation, or controls one or more.

We find an important number of the influential members of the class that is and has been most influential in this country since the organization of the Government, lawyers—the only learned class active in affairs, officers of courts, the chief legislators and law-makers of the

States and nation, the class alone from which the judiciary is chosen—"retained," made comfortable in their income year in and year out, without respect to the duties they perform or the offices they hold, barring judicial positions, by the powerful transportation companies.

We find citizens, officers, law-makers and judges overawed and corrupted by a power that yields no adequate subjection to the powers of the State.

We find a public sentiment alarmed at this situation, but almost despairing how to act helpfully.

We find threats to deal with the matter summarily, and with precedents that it is the unexpected that happens, with knowledge of the destroying power in human society of the ebullition of collected human passion, it is not the part of wisdom not to inquire into and to be indifferent to these threats; and such an inquiry is specially obligatory in a popular government like that of the United States.

The *status* of transportation—whether it is an affair of commerce or the body politic, or part of one and part of the other, and the ill defined thought and the unpronounced action upon it—marks the first point of the difficulty.

Second, we have had a strong leaning to it as purely a matter of commerce.

Third, in the presence of a sentiment that has at length reached public conviction that it is partly at least an affair of the body politic, has arisen an embarrassment of how to treat it as such.

The embarrassment is greatly augmented in the fact that we are under a dual government of local and general authority, between which the lines are not clearly drawn, and which has been a burning question of politics, and many believe may be again fanned into a flame.

The civil war was latterly an affair of sections of the country, but the sentiment that led to it rested largely upon the question of local or general, State or national Government, and many have hoped that no serious point would ever arise again in this controversy. While the railroad problem is not a matter wherein jealousy has been engendered between the States and the General Government, it has been viewed in the light of a matter between local and centralized authority and so subject in some degree to the feeling or prejudice accentuated by the war, that was anterior to it and that largely had its growth as a national issue in the desire of the South to protect the institution of slavery. The result of that war was on the side of the General Government as an issue of local and General Government, as well as in the main issue, but on all sides the distaste is pronounced for more issues partaking of this character.

From the view that transportation, on the colossal scale on which we have railroad transportation in this country, is in some measure a matter of government, it is plain now, and seems as though it might

have been plain at any time, that it is too wide in its scope to be treated successfully by the local State governments. There are two divisions to the subject from the national standpoint:

The position of the Government toward it as defined by the Constitution.

The general ground on which governmental action stands, making it necessary. Of what that action should be, this paper does not aim to treat.

1. The language of the Constitution pertaining to the subject is, "Congress shall have power to regulate commerce with foreign nations, and among the several States, and with the Indian tribes."

Applying this to railroads, the interpretation commonly made is that where a railroad company's chief means of transportation, that is its tracks, extend from one State into another, such railroad company comes constitutionally under the regulation of Congress. The framers of the Constitution certainly had no intention pertaining to transportation in its present form that helps us to interpret this clause of the instrument which they drew; their intention only pertained to the wider generalization—commerce, and must have been suggested by arrangements ordinarily entered into by adjoining States that had no Federal bond. Such arrangements were chiefly treaties. Hence the Constitution debars commercial treaties between States.

"Commerce among the States" is immensely wider in its scope than the mere transference of commodities or passengers over the line of adjoining States. Any railroad or other transportation company that enters into an arrangement with another transportation company for the movement of commodities or passengers from one part of the country to another (and this can not be done except by traversing different States) is a participant in commerce among the States, and so amenable to the clause of the Constitution covering such an act. To claim that a transportation company must actually perform the act of transference from one State into another is standing on the narrowest technical ground, and stands in a very subordinate and unimportant relation to the vital functions of commerce, and would be a poor thing to rest an important relation upon. The company that receipts for property, or sells tickets to passengers, to go out of the State in which these acts are performed, or which delivers property and accepts pay for the transportation of such, which came from other transportation companies and from other States, and which honors tickets for passengers sold by other companies in other States, certainly participates in commerce among the States whether its own property and track is wholly located in one State or not.

2. The special surprise that has taken place in regard to railroad transportation, outside of its mechanical effects (and this is true of other forms of transportation), is the tendency to centralization of management of interests that at the outset appeared to have no special

connection or that were distinctly hostile. Railroads sprang up at first in subservience of local interests, and have been welded and are being welded together in subservience of general interests. The logic of economy and public advantage has overridden the individualities of men, the strifes of communities, the ignorances and prejudices of the public mind. Railroad management becomes less and less local, and more and more an affair dictated by events and beyond the grasp of any one mind or any number of minds that can act in unison. The great names in railroad affairs are not great by reason of overpowering genius, but by reason of the consolidations forced by events, the elimination of the men representing the smaller interests, and by the concentration of power in the hands of him who by his superiority over his associates or competitors, or by something fortuitous, becomes the representative of the combined interests.

The public mind does not grudge extraordinary rewards and power to genius and great public service, but it is galled to see such thrown by circumstances into the hands of men only actuated by personal aims. When such a condition of things grows into a national system; when in substance empires in domain have been parceled out to a few individuals, when we suspect that a few individuals are absorbing the growing wealth of the country, and perhaps more—the past acquisitions; when a plutocracy threatens to become greater than political parties, to wield more power and become superior to the chosen representatives of the people, it is high time to sift the character of their tenure, to inquire whether we have become a nation of *Bombastes Furiosos* in civil affairs; whether the Fourth-of-July oratory of past generations was a mere exercitation of the cerebrum and diaphragm of budding orators or traditionary wind-bags; whether if Providence has favored infants, drunkards, and the United States, as has been intimated by our European fellow-men, has it not withdrawn, or is it not rapidly withdrawing, its favors from the United States? While European nations have been growing toward a greater diffusion of civil rights, in the United States the sovereignty of the individual man has declined, and wealth and a class that wealth creates have become known at the polls and in the Legislatures; and the courts themselves, the very flower of the virtue and intelligence of the people, are strongly charged in some cases with contamination.

Consolidation, consolidation, consolidation, is the trend in the development of transportation. This is so, in spite of the competitive principle on which our nation has sought to stand. This nation has sought to look to no rulers of great and long-continued importance. It has stood on the ground of reinstating its rulers with power at short intervals; this emphasizes the idea that the sovereign power rests with the people. Next to this, the dominating idea on which we have rested has been that competition among our citizens would control our affairs. The theory of no-government—in that part of it which does

not delegate large power to individuals—and the let-alone theory have gone hand in hand in our public policy. But, curiously or otherwise, the compact of thought of the fathers with its traditional acceptance by intervening generations does not hold pure in deed at this time. There was aggressive statesmanship in founding the republic; the statesmanship since that day has not been aggressive. The most distinguished names in civil affairs since that day have been Jackson and Lincoln, whose aggressiveness has been that of repelling innovations or evils; Lincoln broke the back of the slave-power and of the rebellion by his Emancipation Proclamation, and attained the highest point of inspiration and daring ever yet reached by an American statesman; but it was the heroic stroke of defense, not of aggression. No statesmanship arose, during the forty years that it was practically an issue, that was able and aggressive enough to keep back the war for slavery and secession, although it was proved immediately after the war was over that it was a war for an abstraction—an abstraction of selfishness, ignorance, and prejudice that was dissipated in the light of a new day, and an abstraction that might have been dissipated a generation earlier, without the bellows of war, with a different order of statesmanship.

While we may be proud of our founders, we need not be proud of all the statesmanship that has preceded us, nor accept the belief that a final orthodoxy has been reached in this country for the government of a great nation.

It is certainly not the highest order of society that it should be automatic; it is so in China. Accepting this to be the fact, we need not fight off innovations as though in them were the seeds of destruction.

What is it that now confronts us in the *status* of the transportation companies, the monopolies *par excellence* of this country?

The chief proprietors have life-leases of power, to be bequeathed to whom they will, while civil officers and legislators have to go frequently back to the people to be reinstated or deposed.

They have wealth beyond the dreams of avarice.

They build up a subsidiary class around them, who establish colossal fortunes by special rates, rebates, and drawbacks, and are exempt from the American principle of competition. Of this class the Standard Oil Company is the great type.

They possess great power over the incomes and savings of the people by controlling avenues of investment, and can and do greatly use this power to absorb such investments for themselves.

They have the power to tax commerce arbitrarily, and so tax it all they think it will bear, barred only by one strong influence, their internal jealousies.

They check personal ambition, independence, and enterprise, as success in very important fields of activity can only be obtained through them.

The rapidity and ease with which their fortunes have been acquired, the magnitude of their fortunes, their freedom from personal relations, and consequent freedom from sense of obligation to those from whom they derive their incomes, make them a class favored above any other that has ever existed.

And yet the spirit of much of our society is that there is no opposing power to draw upon; it is a case of *laissez faire;* the evil, if it be an evil, and in so far as it is an evil, will work itself out in time.

A representative of the class has drawn a parallel between himself and his class and the highest representatives of the political power of the people. The New York "Sun," of December 14, 1885, gives an account of an interview, between its reporter and Mr. Chauncey M. Depew, concerning the late Mr. Vanderbilt. "The Sun's" interviews, as is well known, are approved before publication by the person interviewed. Said Mr. Depew: "He had a poor opinion of politicians of all kinds. He said to me: 'What is there in politics to be desired? There is no money in it, and by going into it a man breaks up his business and is generally unable to resume it afterward. It lays him open to endless abuse and gives him no end of trouble. There is very little honor in it. Politicians never impressed me at all. I had three United States Senators in my office the other day, and I paid no more attention to them than if they were so many clerks. If they had been great shippers, great railroad men, or great business men of any kind, I should have been interested in them, but as it was I did not understand them. They do not impress me at all. Whenever I go to Washington they want to sell me a patent, or ask for a place on some of my roads, saying that they want to get out of politics.'"

Does not this reflect correctly the opinion of railroad magnates themselves, and in great degree popular opinion, that these magnates are greater than the highest representatives of the people — that there is no law to which, from the pinnacles of their greatness, they are amenable?

I have claimed consolidation as the special and remarkable feature of transportation, whether it be of railroads in any of their forms, telegraph-lines, gas-lines, and still other forms of transportation developed and developing. These consolidations are national and municipal in their character, tending to the bringing any one system, however extensive it may be, under a single management. Instances are almost too trite to be worthy of mention. In the greatest examples, we have the Western Union Telegraph Company; the Huntington, the Garrett, the Gould, the Vanderbilt, and other railroad systems; in municipal affairs, the consolidation of the elevated railroads of New York; in less degree, the consolidation of the ordinary street-lines, and the consolidation of the gas interests. How far do we have to look into futurity to see, judging by the past, the management of the railroads of the United States emanating from a single office?

In this service of transportation the individuals who are served cohere, they become the public; the transportation company, acting in its proper sphere, is the "servant" of the public as the President and all executive officers are servants of the public and of the people. If transportation companies favor one it does not end there, it injures somebody else; the favor received is an injury to the business competitor of the favored one. This is positive evidence, as the condemnations of public and private property for their use is negative evidence, that they exercise public functions.

If it was not profitable for individuals to establish the most approved means of transportation, it would be the duty of the State to establish them. On this theory the United States Government grants lands and its credit for the construction of the Pacific Railroads, individual States have built canals, and cities construct water-works and sewers.

All this, in connection with the character of the power of railroad and other transportation managers, means that they riot in the exercise of public power, and in the execution of public functions, the same as kings rioted in their power before it was satisfactorily demonstrated that their only or most legitimate use was to exercise for the interest of the public a delegated power.

The United States, standing on the ground of *laissez faire* more than any other civilized nation, has been the slowest in asserting itself in regard to the public functions of railroad companies, and, while we can not weigh accurately the value to us as a nation of over-construction and over-competition in railroads, presuming that there has been a value in them, we have had violence done to the spirit of our institutions; we have had the conditions of life, actual or relative, made harder to the average man; we have had suspicions cast upon the *dictum* of Lincoln, that this is a government of the people, by the people, and for the people; and we have seen the transportation corporations usurp or control the wealth, the honors, the Government (of their own specific and of a general kind) of the United States in a way that is abhorrent to the general sense of justice of civilized, or at least English-speaking, people. We have arrived at that position where we can not claim much advantage except our virgin soil, and what comes from our extent and isolation, over the governments of Europe that emerged into civilization from the dark ages, whose people have been afflicted with the theory of the divine right of kings, and who are, in one country or another, now loaded with primogeniture, entail, aristocratic orders in society, church government imposed upon state government, and a system so prejudicial to personal advantage that years of youth are condemned to participation in, or preparation for, war. The special kind of humanity that, it has been claimed, grew and would continue to grow on American soil, seems to have many departures from the boasted type, and we assimilate more and more to the older govern-

ments, or—if we go on as we are going shall we not be forced to admit it?—to the more steadfast types of civilization.

Already the Toryism of Great Britain is looking with admiring gaze to the Democracy of the United States, rapidly establishing, as it is, a privileged and a favored class, and such leaders as Chamberlain and Morley, on the crest of a forward movement, men of office and a great following, forge ahead on the line of equality and freedom such as the latter part of the nineteenth century has brought forward, and give small heed to the teachings and institutions of the United States.

Back of all these facts and postulates is the question, How far is transportation legitimately a subject of government, a branch of government—this as distinguished from being a matter merely of commercial enterprise? We see how easily transportation runs to one head, to one leadership. Competition does not keep this back; we have thoroughly tried the competitive principle, with all the predilections of our people and our Government in its favor, and it has failed; competition has been eliminated; *nolens volens*, the single leadership is arriving or has arrived. The question, then, is, Is that leadership to be held by a single individual intent on seeking his own fortunes, building up bulwarks of private fortunes around him; breaking down resentment to his *bizarre* position by travesties of courts, by legislators who smile and smile, and see their way to vote for him, by *douceurs* to the placable, by dollars at elections, by free rides, by telegraph-franks, by proprietary and subsidized newspapers, by retainers to high-roller lawyers, by political economy manufactured expressly for his benefit, by pillars of society droning of the dangerous tendency of the times, by *laissez faire*, by audacious self-assertion and robbery, by chameleon politics, by lofty public spirit, by smiles, lies, and entreaties, by the advertising generous hand, by the adulations of intelligence and virtue which millions of dollars so easily command, and—when all else fail—by sordid and brute force pressed home on the weak or galled spot of the body politic or the private interest? This is the commercial side of transportation as presented in the United States in the year of grace 1886. Would it not be well to see what there is in governmental transportation, to pay some attention to the experience of contemned monarchical governments, to cry a halt on the liberty that permits one or a few to absorb the substance of the state; to organize this, or commence it at least, by some of the simple forms of regulation that demand publicity, that ferret out discriminations that mean commercial theft and punish them, that stop vibrations between low and high rates in accordance with the whims of disturbed gall or exultant avarice of transportation rulers, that stop the prior knowledge of a favored few of what is to be, and so deprive them of enormous advantages in trade and transportation?

This is the way, or the most important step, in the limitation of

wealth in the United States. Place no embargo on enterprise by a dead-line on which is written, "Thus far shalt thou go and no farther." Let the incentive of ambition, of avarice, if you will, be keen to the last, but hedge the opportunities so that no one man's opportunity greatly exceeds that of others; put the strain, not on getting a living, a competence, but on getting enormous multiples of these. Even then extraordinary fortunes may come, but they will come as the result of circumstances that could not be guarded against, and as the result of commanding and extraordinary talent that never comes in rafts (which would be implied if the present great fortunes were taken as a criterion of ability), and these sporadic fortunes will not be a threat to and a corrupter of society; they will not build up a separate class; they will be seen as only one of the unusual things in social development.

A government relation to and regulation of railroads is classed with a larger general regulation of society by Government than we have heretofore had, and which is in course of development in Germany under the leadership of Bismarck; which is constantly attaining greater ground in England in the popular mind under the leadership of Chamberlain and others, which is not strenuously objected to by Gladstone, and which bids fair, when that at present disturbed country gets rest from the exciting Irish question and has time to recover itself from the excitement of its recent foreign complications, to express itself in laws bearing on the internal polity of the country. The United States has not greatly entered the lists in this respect. It has not enlarged upon the principles of government incorporated by it in the Constitution; it has been almost the last to yield the principle of slavery, and now stands by, seeing Germany, at least, trying experiments in government which it has not ventured upon. It must be ranked at present among the conservative governments of the world. The national trepidation of "reforms" is greatest in Great Britain, where there is not the absolutism to hold them in check that there is in Germany.

Suppose we want to stand on the ground of incorporating no new principle in our Government, where does that leave the railroad problem? We see the consolidations that have taken and are taking place. Those consolidations mean centralization, and centralization has been the *bête noir* of the United States. The question is, Shall that centralization remain in private hands, with the various ills and violence to our institutions that we are positive of, or shall it come under subjection to, or be shared by, the agents and representatives of the people?

Certain things are natural in their regulation and government. The first of them is the war-power, which is the starting-point of civilization. Next is the preservation of order from disturbance by internal outbreaks and violence, which is the function of the police.

There is the preservation of custom and the growth of equity, which is the function of the law, the courts, the Legislature; and there is the execution of the law, which is the function of the ruler and his assistants. A superior civilization aids commerce by the establishment of lighthouses, by improvements of rivers and harbors, constructs canals, looks after the public health in the establishment of quarantine, prevents the spread of infectious disease, provides cities with water and sewers, seeks to insure education among its citizens, regulates and controls the medium of exchange. The governments of civilization have been progressive in these regards. This country now confronts the problem of too great power in the hands of the wielders of transportation—they thwart the first principles of our Government, and the iron of their oppression has entered into the soul of our people.

BOHEMIAN GLASS.

By Professor HEINRICH SCHWARZ.

THE northern edge of Bohemia, which borders on Silesia, Saxony, and Bavaria, is at once the principal seat of the German population of the country and of its industrial activity. A person approaching this border region from the interior will be struck at once with the contrast between the stagnation of the Czech districts and the freedom and active enterprise of the Germans, under the impulse of which a not very fertile soil has been made to support a dense population. Besides the textile industries which profitably utilize the water-powers of the mountainous region, and the large mining, metallurgical, and chemical enterprises, the ceramic establishments, and the manufactories of stone-ware, porcelain, and glass, are prominent features of the district.

Notwithstanding numerous efforts, the quality of the famous Bohemian art-glass has never been quite equaled anywhere else. The principal seat of its production is in Northeastern Bohemia, where this district is separated by the Riesengebirge from Silesia; but, as the result of the active trade which has been carried on over that chain for several centuries, branches of the manufacture have also spread into the latter country. The exquisite products of the *Josephinenhütte* at Warmbrunn have long maintained a rivalry with the Bohemian wares, and Frau Heckert's establishment in Petersdorff can exhibit wonderful specimens of luster and color, polish and etching, that might almost make one imagine he had been transported into Aladdin's palace. The bases of the manufacture are really the same on either side of the range. The mountains furnish a pure quartz and a limestone of snowy whiteness for raw materials, and the abundant woods, with which they were clothed, formerly supplied the best of fuel to the furnaces, while

the resultant ashes afforded the necessary potash. The Bohemian crystal serves in art as the type of the most perfect glass, and is unquestionably recognized as one of the superior kinds, rivaling in transparency and clear whiteness rock-crystal itself. Pure specimens of it, free from blisters, grains, and specks, have a peculiarly attractive look, even in their simplest forms. It is, moreover, by reason of its tenacity, its constancy of luster, hardness, and difficult fusibility, eminently adapted to artistic molding and ornamentation.

The heating of the furnace with wood only, from which a comparatively small quantity of ashes was produced, and they entering into the composition of the glass, contributed no little to the attainment of the highest perfection. While the glass-houses were at first built where they might be made a means of utilizing the superfluous wood, they have now to contend against a continually rising price of wood and increasing difficulty in procuring it. Some factories, like the Josephinenhütte of Count Schaffgotsch, and that of Count Harrach at Neuwelt, have the extensive forests of their owners to rely upon, while the much more important establishment of Joseph Riedel in Polaun is looking forward to direct railroad connection with the lower Silesian coal-mines or the Bohemian brown coal.

While formerly only the best, finely-split, well-seasoned trunk-wood could be depended upon to heat the furnaces to the needed temperature, the required degree is now obtained from limbs, knots, roots, and even green wood, by distilling the gas from them in an imperfectly ventilated regenerator, and burning it with the aid of previously heated air. By this means is obtained a clear, excessively hot flame, by which the most infusible glass is made as fluid as water, and of a very high state of purity. Many experiments will be necessary before such excellence can be obtained with coal-gas; and, in any event, a previous washing of the gas will be required to clear it from tar and ashes. The form of the furnace, the manner of introducing, purifying, and tempering the glass, the processes of bringing it into shape, and the shaping tools, do not vary essentially from those of the old ways; except that complicated figures engraved in iron and brass molds are now applied, the complete transference of which to the glass necessitates the use of air under high pressure. This is furnished by means of a hand compression-pump, so arranged in connection with the other parts of the apparatus that the manipulator can bring it to bear upon the melted glass at the precise moment when it must be brought into the closest contact with the engraved pattern. Other pieces, of a massive character, such as lenses and ring-segments for lighthouse-lanterns, which are now made on a large scale at Polaun, are formed by subjecting the material to a light pressure between an upper and a lower mold. They are then finished and polished after they have cooled.

The after-decoration of the glass is various, and subject to the fre-

quent changes of fashion. New patterns bring a high price and find a ready sale till they are crowded out of the market by newer ones. For a long time the old German fashion ruled in glass, and manufacturers were obliged to use crude, impure colors, as if they were working in the childhood of art. Now, when we remember that glass-work has been regarded from a time long past as properly an effort to obtain the clearness of rock-crystal and other precious stones, it should appear that it was wrong deliberately to come down from that high ideal. The question is the one involved in the old contest of the artists with the artisans, which is still carried on with reference to the modern coal-tar colors. The former dislike these colors because they are too pronounced; the latter are inclined to regard them with more and more favor, on account of their brilliant luster, purity, and strength of color.

The author's studies of the Venetian mosaic glasses satisfied him that the harmony of the designs composed out of them was due to the subdued, broken coloring of the pieces that entered into the work, and that this was due again to the application of an impure, ferruginous sand in the melting. We must not, however, forget that glass is used in our houses, along with the precious metals, to bring out the highest lights, which even the most harmonious pictures can not dispense with. The purer, the more lustrous, and more brilliant the color of the glass, the better it answers this purpose.

The ornamentation of the glass is done partly in connection with the exposure in the furnace, and partly in the finishing-shops, where the work is completed by cutting, polishing, tarnishing, etching, painting, and mounting in metal. The glass-houses have at their command a very complete color-scale for transparent, opaque, and clouded glasses. But it must not be supposed that a crucible is placed in the furnace for each color, from which glass colored for each ornament is to be made. The colors are worked out by means of what are called pastes, which are kept on hand in sticks or cakes. From pieces of these pastes previously warmed till they are soft, suitable quantities are cut off, laid upon the foundation of white or colored glass, and then spread out by drawing or blowing. By this means only is an economical use of such costly materials as gold and silver compositions possible. Some of the glasses thus treated—gold, copper, and silver glasses—remain still little, or not at all, colored after the melting, shaping, and quick cooling; and do not take on their bright hues till they are reheated. This is the case with the new yellow-silver glass, which continues uncolored after the intermelting of the silver salt until it is exposed in the furnace again. Very fine effects are produced by blending or overrunning of the paste-colors provided proper attention is given to the laws of harmony. A blue-glass cup is, for example, overlaid with silver glass at its upper edge, and this is drawn down in gradually thinner tones till it fades away at the foot of the vase. Gold and copper ruby-colors are thus combined with green

glasses, etc. Another brilliant effect is produced when a still hot bulb of glass is rolled in finely pulverized aventurine glass,* and after this is melted, and previous to the shaping of the vessel, is overlaid with a coating of either colored or colorless glass. A still finer effect is obtained with mica-brocade. The mineral mica, which has deceived so many persons by its golden or silvery glitter, besides being applied as a substitute for metallic bronze dusts, can be colored by the aniline dyes in all manner of colors and shapes. The coarse powder called brocade is used in glass-work, and the color-effect is produced by overlaying it with colored glass. A bulb is blown, for example, out of clear blue glass, is rolled in the brocade, which readily adheres to it, and is then overlaid with yellow glass. The brocade will appear, when looked at from within, of a steel color; from without, of the color of gold. Every flake will reflect the light, colored according as it is looked at.

A recent kind of decoration is shown in those glasses which appear to be held together by a network of gold-thread. This is made by preparing a skeleton of brass wire, and then introducing the glass and blowing it till its mass, having penetrated the interstices of the network, spreads over it and tightly incloses it. The full effect is then brought out by a subsequent etching away of the metal, and galvanic gilding or silvering. Other metal ornaments, insertions, buttons, drops, or *figurini*, are often combined with this. They are cast in steel-engraved forms of type-metal, which reproduce the finest details, and are then galvanically coppered, silvered, or gilded. Another pretty effect is obtained from the clouding which glasses mixed with bone-ashes exhibit on being heated. If a bulb of this kind of glass is blown into a metallic form which is dotted with projecting points, a quick cooling ensues at these places, which leaves its mark after the reheating and finishing in the shape of a regularly distributed clouding.

Only a little need be said, and that of the most modern operations, of finishing, of the grinding, tarnishing, and polishing, ornamentation with gold-leaf and platinum-foil, luster, and enamel coloring, etc. One of the most noteworthy of these operations is that of tarnishing by the centrifugal sand-blast. The objects to be treated by this process are fastened upon revolving wooden pegs in the walls of a wooden box; the sand is introduced into the middle of the box, and is thrown by rapidly rotating fans against its sides and against the glass figures. After it has done its work upon the figures it falls upon the funnel-shaped floor, to flow away and be lifted up again.

A charming effect is produced at the Neuwelt houses by means of a guillocheeing machine in which an engraver's tool is drawn in regularly massed lines over the slowly revolving vase. The vessel has been

* A glass containing bright metallic flakes, probably copper crystals in a brown magma. It is made with rare perfection, by a secret process, in Venice.

previously covered with etcher's varnish, which is removed from the lines of the engraving, where the bare glass is afterward exposed to hydrofluoric acid. In this way are produced the wave designs resembling those which are seen on the more finely engraved bank-notes.

In another very recent style of ornamentation, fine Venetian glass-pearls of various colors are glued by a very fusible enamel upon the surface of the finished vessel. As the arrangement is made in the cold, the work admits of a complete artistic freedom. The enamel is then dried and the setting is fixed by heating.

Another important function of the melting-furnaces is to furnish raw material for the now considerable small-glass industries in the shape of sticks and fragments of colored glass. The favorite color for these is a dark violet or black; but colorless glass is used for the pendants of chandeliers, and they are sometimes given a reddish tint by overlaying them thinly with gold-ruby. Sticks partly overlaid with opaque glass are used in a similar manner. There are always accumulating, in the glass-houses and other shops, piles of droppings, overflows, and pieces of many colors, which can be sold for very cheap prices. All this stuff is pounded up and mixed together with the addition of manganese or other coloring oxides, and is remelted in a special furnace. The workmen take out suitable quantities of this mass, and, by a series of deft manipulations, form it into sticks about as thick as one's thumb.

Very thin globes of about the size and shape of a vitriol-flask are made from the same dark glass, to be again broken up into sherds, which can be packed away in boxes. The manufacturer cuts from these sherds slightly curved plates, such as are used, for example, as foundations for brocades.

The shops of the small-workers are of the simplest character. Wherever one of the numerous little streams makes it possible to get water-power enough to drive a grinding and polishing wheel, and in the modest houses scattered along the mountain-slopes, may be found the establishments of these industrials, in which the working force of the whole family finds active employment. The artisan buys his sticks and sherds from the glass-house. A little wood-furnace, somewhat like a tinker's furnace, gives facilities for heating four or five of the glass sticks at once, which are taken out and used alternately as the ends are softened in the fire. The softened end is fastened upon by a pair of pincers, drawn out a little, and introduced into a mold in which is carved the figure of the object into which it is designed to be formed, and which is firmly stamped upon it by closing the mold and the application of pressure. If the mold is too cold, the form will be imperfectly made and the glass will be brittle; if it is too hot, the glass is liable to stick in it. Fortunately, it can be easily worked to a suitable temperature. The molded pieces are thrown into an earthen

pot, which is kept warm by a moderate flame and serves the purpose of a cooling-vessel.

The button, or whatever is the article manufactured, is still only in the rude state, with the edges yet rough and the surfaces uneven, but already provided with holes for the after-insertion of metallic eyes. The rough edges are smoothed away by grinding on the grooved periphery of a wet sandstone, being held to it by a wooden clamp which is managed by the right hand while it is turned with the left. The surfaces are ground with wet sand on horizontal, fast-turning iron plates, and afterward polished on the face of soft wooden wheels roughened with Tripoli dust. To speed the operation, the workman presses upon the piece with both hands and gives it a peculiar rotary motion that equalizes the stronger friction to which the parts nearest in contact are exposed. The proper application of this movement is a matter of knack, and is founded on mathematical principles, which also appear when the object is rubbed on a solid base, in the epicycloid lines which it is made to describe. On account of the relatively long time required for the operation of polishing, the smaller articles are subjected to what is called a fire-polishing, in which the smoothly ground pieces, imbedded on a plate of clay in fine sand, are heated in a muffle till their surface runs. If more strongly curved plates are wanted, to form a rose, for instance, the disks, previously prepared by notching and perforation in the middle, are placed in funnel-shaped crucibles in the hot muffle. The central part of the disk sinks on being heated. The hollowed leaves are then set one in another, in the order of their diminishing size, and fastened together by a glass-headed pin.

The foundation of the design is formed of a brass plate which has been previously shaped and perforated. Additional decorations are given by means of little beads, which are melted off in the glass-blower's lamp from thin threads of glass, and find their places in minute holes in the plate. Black sealing-wax is added to heighten the gloss and the blackness, as well as to cement the parts together. In other cases lighter figures are made by partly polishing or by etching them out on the smooth background. Iridization of beads, buttons, etc., has been much in vogue for a few years past; by this process those articles are given a metallic appearance. The luster of gold or silver is imparted by covering the black glass with a silver- or gold-leaf varnish and afterward heating moderately in a muffle. Peculiar tarnish-effects are given by the application of what are called luster-colors; and, lastly, these are shaded by a brief treatment with chloride-of-tin vapor. The glass articles, hung upon a wire, having been previously warmed in the muffle-furnace, are drawn through the thick white vapors which are formed when a spoonful of the tin-salt is dropped upon red-hot iron. A long experience and considerable manual dexterity are required to make sure of getting the particular iris-color

that is wanted, which is dependent upon a very well-defined minimum thickness of the coating. In this is involved a question of interference-colors, the same as is involved in soap-bubbles and the temper-colors of steel, in which there must be an exact difference in the wave-lengths of the light reflected from the upper and lower surfaces of the coating. Many colors, like steel-green, require repeated trials to be brought out in their full beauty. The advance that has been made in this art has been illustrated to me in a specimen-sheet of beads which are designed to make trimmings exactly corresponding in color for silks of a very great variety of shades.

In addition to the glass industry, a very extensive interest has been developed in the manufacture of brass, bronze, pinchbeck, etc., in which use is made of various galvanic coatings of metal. These branches of the art are carefully taught in the industrial school at Gablonz.—*Translated for the Popular Science Monthly from Unsere Zeit.*

GEOLOGICAL CLIMATE IN HIGH LATITUDES.*

By C. B. WARRING, Ph. D.

THE peculiar climate of geological times has hitherto been treated as if it were a question of temperature only. Scientists have sought the cause of the remarkable warmth in arctic regions, but have left untouched other questions of equal and perhaps greater importance.

One can hardly contemplate the climatic conditions of that remote period without inquiring how there could be other than a great difference of temperature between the summers and winters of lands less than 8° from the pole; and how could circumstances—environments—so unlike as the four or five months of day of those regions, and the twelve-hour day of the tropics, fail to induce great specific differences in their fauna and flora. The questions spontaneously arise: Is it possible that the days and nights in high latitudes were then as they are now? Must not the climate have been warm in January as well as in July? Must not the influences of the solar rays—the actinic force—have been distributed through the year with at least approximate uniformity in high as well as low latitudes? It is these questions, as well as those of temperature, that I shall consider in this paper. I propose to study the record left by the plants and animals which lived in those remote days. Some of their more obvious teachings are startling enough. Regions where now vegetation is of the scantiest character, where no trees exist save a few dwarf willows, where the winters are cold almost beyond endurance, were, as late as

* Read before the New York Academy of Science.

the Miocene, covered with magnificent forests of magnolias, oaks, cypresses, and a hundred other species. In more remote periods they abounded in plants and animals, whose fellows of identical species lived at the same time,* or at least in the same geological period, near the equator.

These statements are so extraordinary that they need to be established by unanswerable evidence. Of this there is a great abundance.

In latitude 81° 40′ Captain Nares found the remains of corals in vast quantities. These creatures require not merely a warm but an equable temperature. Those of to-day can not live where the temperature falls below 66° Fahr. Sir Charles Lyell says: "The same genera, and to some extent the same species, of Ammonites are found in those high latitudes and in India. Remains of a large ichthyosaurus were brought by Sir Edward Belcher from latitude 77° 16′. Others were found by the Swedish expedition in Spitzbergen, latitude 78° 10′." In Dana's "Manual of Geology," under the heading "Climate," in all the early periods, abundant illustration is given of the uniformity of climate in high and in low latitudes. On page 181 he sums up in these words: "No marked difference between the life of the primordial period in warm and cold latitudes has been observed"; and again, on page 253, "The living species, from 30° to 80°, were in part the same, or closely allied."

It is unnecessary to multiply proofs. All geologists agree that, all over the world, the plants and animals of any particular horizon were exceedingly alike, and very often identical. The living species to which they are most nearly allied are peculiarly sensible to changes of temperature.

So far, therefore, as it is possible to judge the past by the present, the fossils indicate a warm and uniform temperature almost to the poles, such as is now found in regions inhabited by similar species. Geologists are forced to this conclusion. In that wonderful work, Professor Dana's "Manual of Geology," it crops out everywhere: Page 266, "There is no sufficient evidence of cold arctic seas"; page 289, "There was little difference of temperature between temperate and arctic seas." (See pages 352, 452, 480, 488, 514, 521, 526, etc.) All tell the same story. "No zones of climate." Warm arctic seas all the year round.

It may, however, be thought that no very certain conclusions can be drawn from these facts, because the identical species which flourished in those remote times are no longer extant, and perhaps they

* It is of small importance, in reference to these questions, whether Huxley's "Homotaxy" is true or not. If true, then these same species lived first in high latitudes, and afterward in low, or *vice versa*. The important point for my present inquiry is, that the same species lived and flourished in places where life-conditions now are so extremely unlike.

were not so sensitive to cold as are their closely allied successors. There is some force in this, but we must not give it too much weight, for all progress in knowledge of the world's history is based upon the belief that, in general, corals in Palæozoic times indicate such conditions as exist where we now find corals; saurians, where we now find saurians; tree-ferns where we now find tree-ferns; and so of other organisms. As soon as we leave this principle, we are at sea without a compass, and almost without a star to guide us. There is direct evidence of the warmth of climate in the Tertiary, and, if this be established, there will hardly be dispute as to the climate of the earlier periods. Plants of living species which require not only a mild temperature, but one of great evenness, have been found in very high latitudes. In Spitzbergen, latitude 78° 56′, there have been found the remains of a Miocene flora remarkable for its variety and luxuriance. One species, *Libocedrus decurrens* (Heer), now lives with the redwoods of California; another now occurs in the Andes of Chili; while a third, according to Dr. Gray, is the common *Taxodium*, or cypress of the Southern States. In Greenland, latitude 70°, were found magnolias and zamias.* All these require not merely a warmth *but an evenness of temperature* that in such high latitudes is extraordinary; extraordinary and incomprehensible, if then, as now, the solar heat was wholly shut out for more than four months. It will help to realize the difficulty of a uniform climate in regions 75° to 85° from the equator, if we consider what now would be the effect of a four months night covering the torrid zone, and remember that the cold of arctic countries is not due to their position, but to the absence of the sun's rays caused thereby. The accumulated heat of summer, great as it is at the equator, would soon be radiated into space, and, when the sun returned, not a living plant or animal would remain to greet it.

The effect would be no less fatal if the long nights occurred in a zone extending, say, 20° north or south of the Gulf States. Consider the effect produced now by a slight lengthening of the night, and then say how complete would be the destruction if the night's duration was increased from a few hours to four months!

In geological times, if the axis of the earth had its present obliquity, the midwinter nights in Spitzbergen, where the plants I have mentioned were found, were four months long. The resulting changes of temperature must have been very great. At the present time they are enormous. Captain Nares† says that the thermometer at his winter quarters fell in March to −73·7°. For thirteen consecutive days it showed −59°; for over five days −66½.° The variation between that and summer must be something enormous, for Mr. Meech has shown in his paper on "Solar Heat," published in the "Smithsonian Contributions to Knowledge," that the amount of heat from the sun received in high-

* Dana, "Manual of Geology," revised edition, p. 526.

† Captain Nares's report in "Nature," vol. xv, p. 35.

latitude regions, during the three middle months of the arctic day, is greater than is received in the same time at the equator.

In Dr. Kane's "Arctic Exploration," we read that the difference between maximum and minimum (summer and winter) temperature, in latitude 78° 37′, was 120° Fahr. At St. Michael's, latitude 63½°, the thermometer ranged from +76° to −55°, a variation of 131°. It would, I think, be a moderate estimate, should we attribute at Spitzbergen a variation of 100° to the changes in the sun's declination, or, in other words, to the obliquity of the earth's axis.

The cold undoubtedly was greatly modified by the latent heat of the surrounding ocean, and by the inflow of ocean-currents. But the same capacity for giving off heat exists now, and the same currents continue to flow; yet in Spitzbergen—a not large island, surrounded by a broad expanse of water—the cold is very intense. The specific heat of water has undergone no change; so far as that is concerned, the surrounding ocean does as much now, as then, to make the Spitzbergen winters mild.

Did the Gulf Stream, or the Japan Current, in those remote times, have a greater flow than now? Their effective cause is the difference between polar and tropical temperature. If this was nothing, the flow would be nothing. In geological times the difference of the temperatures must have been small, since the same species of plants and animals extended from the tropics to as near the poles as has been explored. Hence the flow of these streams, to say the least, could not, in those times, have been greater than it is at present.

Whether 100° is an overestimate of the difference between the summer and winter temperature at Spitzbergen, due to the long days and nights, it is certain that the sun produces a great effect upon the temperature in high latitudes. Whatever other thermal influences may have existed in the Miocene, or in other and earlier periods of geology, their effect was no greater in winter than in summer. Admitting it to have been the same—a matter of great doubt—the temperature, as the nights grew longer, must have fallen until it reached a point at which the loss of heat, by radiation into space, was just equal to that brought in by the ocean-streams, and by such aërial currents as might blow from warmer regions.* In summer there were the same sources of heat plus a sun shining not twelve nor fifteen hours, but for months. Calling the winter heat A, and the increment from the sun B, the heat during summer equaled A plus B. The difference at the present day between the temperature of arctic seasons is enormous. It is difficult to see how it could have been so reduced as to render life possible for plants whose fellows of the same species were, at that very time, growing in regions thousands of miles nearer the equator.

* Stellar heat need not be considered, as it does not vary, and, besides, it is very small.

The fact of their continued existence, not dwarfed and scanty, but with greatness of size and luxuriance of growth, seems to indicate that there could not have been a total cessation of solar heat for months in winter, and an uninterrupted influx for months in summer. In other words, the evidence of plants and animals points to the absence of present long days and nights.

However it may be, as late as the Tertiary, geologists are agreed that at least to the end of the Palæozoic there is a lack of any indications of zones of climate,* or, to put it in another form, that there is evidence only of evenness of climate.

I next inquire, What is indicated as to the length of the arctic day by the effects of light upon plants?

In all discussions of these curious facts—at least so far as I have seen—no attention has been paid to the effect upon vegetable and animal life, of the great difference between the length of the days and nights in high and low latitudes, even though the temperature were kept up. In Spitzbergen, for example, the sun shines uninterruptedly for four months, and for an equal time its rays are cut off, while in tropical regions a day of twelve hours is followed by a night of the same length. In the temperate zone the day is at most but a few hours longer. If the earth's axis in preglacial times was inclined 23½°, the same inequality prevailed then. Light is as necessary to plant-life as heat, and, in respect to the character of the polar day, its evidence is more important, since light is affected only by the inclination of the earth's axis. The flow of the Gulf Stream, the lay of the land, or the relative amount and arrangement of the land and water—matters of great moment when considering questions of temperature—have no effect whatever upon the length of the day, or, in other words, upon the mode of light distribution.

Mr. Darwin and his followers have called attention to the influence of environments in destroying old species and in the production of new. In view of all that they have established, it seems incredible that species identically the same could have lived and shown luxuriant growth, say in Spitzbergen and Florida, through thousands and millions of years, unaffected by such difference as now exists in the length of the days and nights. The arguments against the reality of such a difference become stronger when we reflect that in both high and low latitudes there were from period to period enormous changes in species, old ones passing away and new ones appearing, not once, nor twice, but a great many times, and yet at each epoch the new species,

* Dana's "Manual of Geology," third edition, page 352, says: "If we draw any conclusions from the facts, it must be that the temperature of the arctic zone differed little from that of Europe and America. Through the whole hemisphere—and we may say world—there was a genial atmosphere" (and corresponding conditions as to actinic influence) "for one uniform type of vegetables, and there were genial waters for corals and brachiopods."

from the shores of the Arctic Ocean to the coasts of Bolivia, were everywhere largely the same; always enough of identical species to show that arctic and tropical environments were essentially alike. It seems, if possible, still more incredible that in later times—say, in the Miocene—species which originated in Spitzbergen and upper Greenland could migrate to low latitudes, and still show no change in specific characters.

It certainly was to be expected that conditions so unlike—I refer, now, only to the long days and nights—should have been attended by widely diverse plant-life.

The belief that such would have been the case is strengthened by the fact noticed by Mr. H. C. Watson, and quoted approvingly by Mr. Darwin in his "Origin of Species," that, "in receding from polar toward equatorial latitudes, the Alpine or mountain floras really become less and less arctic."

But, were they truly arctic, and identical with those now in Spitzbergen, such floras, accustomed to a hibernation of nine months, might well be indifferent as to where that time was spent, whether in the cold and continuous darkness of an arctic night, or in the cold of a winter on a low-latitude mountain-top. On the other hand, the plants, e. g., of the Carboniferous, were not arctic plants, but were warm-temperate, if not tropical, and there was no arctic cold, but "a warm, moist, equable atmosphere,"* in which they "flourished luxuriantly."† Another corroborative fact is found in the peculiar structure of certain post-glacial arctic trees. A conifer, found standing in latitude 72½°, and of post-glacial origin, was brought to England by Sir E. Belcher, where Sir William Hooker made a microscopical examination of its structure. He found that it differed remarkably from any other conifer with which he was acquainted. Each annual ring consisted of two zones of tissue: the *inner zone was narrow, of a dark color*, formed of more slender, woody fibers, with few or no disks upon them; the outer zone was broader, of a pale color, and consisted of ordinary tubes of fiber of wood marked with disks such as are common to all coniferæ. These characters he found in all parts of the wood. They suggest, as he says, the annual recurrence of some special cause that modified the first and last formed fibers of each year's deposit, and this cause, he thinks, is found in the peculiar conditions of an arctic climate, where the days were at first very short, a few hours only of sunshine. Then the first and imperfectly developed fibers were formed. As the days grew longer and longer, and the solar rays at last became continuous, the woody fibers became more perfect, and were studded with disks of a more highly organized structure than are usual in the natural order to which this tree belongs.‡

Since Spitzbergen is nearly 5° farther north, such or similar effects ought to show themselves there in greater intensity in the conifers of

* Dana. † Lyell. ‡ See this account in Croll's "Climate and Time," pp. 264, 265.

early geological times, if the same causes then existed. Whether they have been specially searched for, I do not know; but their absence, if established, would strengthen the conviction that the conditions of arctic climate which produced such a peculiar mode of growth did not exist in the time—many thousand years earlier—when libocedrus, magnolia, and zamia were denizens of high latitudes.

There are other facts whose tendency is in the same direction.

It is admitted by all that the climate in the earlier geological times and down to the end of the Miocene was warm through the whole year. If, therefore, the earth's axis was then inclined 23½° as now, the plants of Spitzbergen and other high latitudes must have spent during every year of their existence more than four consecutive months without a ray of sunshine, and surrounded by an atmosphere moist and warm.

Their condition resembled that of plants in a warm, dark, and moist cellar. Modern vegetation so placed soon bleaches and dies. Undoubtedly it was possible for a specially adapted flora to exist under such circumstances. And a special flora is what we should expect. But the flora of Spitzbergen was not special; it was cosmopolitan in all the earlier periods, and in the Miocene some of the identical species flourished there with "amazing luxuriance," whose descendants, with specific character unchanged, are now found in the Southern States of our own country. It seems to me that this is presumptive evidence, if not demonstration, that as late as the Miocene the long arctic nights were unknown.

Moreover, this very luxuriance of foliage, which so surprised Lyell and other geologists, tends to the same conclusion. It is a matter of common observation that plants exposed to the full force of the sun's rays have smaller leaves than others of the same species which are somewhat protected. It would seem as though Nature compensated for the inferior intensity of the solar action by giving more surface to be acted upon. Now, since the intensity of the sun's rays varies as the cosine of the latitude, it is evident, in case the sun underwent no change in declination, that, while the length of the day in Spitzbergen and Florida would be the same, the intensity of the light in the latter would be almost double. Hence, if the earth's axis really was nearly or quite perpendicular, with the same conditions as to moisture and warmth, we ought to look for greater breadth and length of leaves in Spitzbergen than in regions much farther south, and we find them.

I know of but one fact in the geological record which seems to point to the existence of changing seasons. Fossil exogenous trees of very early times have been found with well-developed growth-rings, and, as these are usually attributed to seasonal changes, it has been said that they prove the existence of seasons; and, as these are due to the obliquity of the earth's axis, any inference to the contrary from other facts must be wrong. But growth-rings do not of necessity indicate

summer and winter. They may occur several times in a summer, or not at all, or once in several years, or where there is absolutely no change of seasons. I have seen a hard and woody stem of *Chenopodium album*, not more than four months from the seed, in which were eight well-formed rings. Dr. Gray says there is "a woody *Phytolacca* which makes at least twice as many layers as it is years old," and that cycads require several years for one layer. The orange and lemon, in green-houses, where seasons can hardly be said to be known, form rings as well defined as those of our forest-trees. On the Amazon, as may be seen in a collection of woods now in Vassar College, the rings are very apparent in some species, while in others equally exogenous none can be seen. The mangrove, which grows in the tropics on the sea-shore between high and low water mark, where by no possibility can there be any annual change either in temperature, or from wet to dry, has the rings well developed.* These facts suffice to prove that the existence of growth-rings is independent of the existence of seasons.

I think it must be admitted that the teachings of geology are in harmony with what would have been the climatic conditions in high latitudes if the axis of the earth was then perpendicular (or nearly so) to the ecliptic, provided that in some way the temperature could have been kept up sufficiently. And, if there be anything in the influence of environments, the lack of results corresponding to days and nights so different as those, e. g., of Spitzbergen and Florida, is evidence that the days and nights in those countries did not differ then as they now do. If there was no such difference, the earth's axis then did not incline as it does at the present day.

The tilting of the earth, or, in other words, changing the direction of its axis—if gradual—would occasion no perceptible disturbance. Hence no conclusion is to be drawn from the absence of traces of such a cataclysm as would have attended a change of the geographical position of the poles. The latter, however slowly brought about, would have necessitated a change in the position of the equatorial protuberance, or, if the crust was too rigid for that, a change in the ocean sufficient to overwhelm the land. The only possible effect of an increase in the obliquity of the axis would be an increase in the length of the days and nights in high latitudes followed by corresponding climatic changes. These would have registered themselves in the plants and animals of high latitudes, while near the equator the effect would be scarcely perceptible. Days and nights in low latitudes would be only slightly affected, consequently animal and vegetable life would continue as before. It is corroborative of such a tilting, that the plants and animals in high latitudes, which, till near the end of the Tertiary,

* See "American Journal of Science," 1878, Article XLV, "Is the Existence of Growth-Rings in the Exogenous Plant Proof of Alternating Seasons?" by the present writer.

had been the same as in low latitudes, became wholly changed to new species after the Tertiary, while those in low latitudes remain as they were in general character, and, in some cases, the identical species yet survive.

In our Southern States, for example, the flora is closely allied to, and as to some species identical with, those of the Miocene of arctic regions. From the Miocene back, the geological record tells of life-conditions—environments—the same all over the world.

So far, therefore, as geology is concerned, the evidence appears to be all one way, and I think I am justified in saying that the conclusion to which it points would be readily adopted, were it not for reasons derived from another science.

Astronomers say that a permanent change in the inclination of the earth's axis by means of any force known to science is impossible. We know, however, very little of the means by which our system was brought into its present state.

The only theory that attempts to explain, on purely mechanical principles, the existence of the solar system is the nebular hypothesis in some of its forms, although even that requires a self-existent entity back of it. According to this hypothesis, the earth and moon were once one body, which revolved, of course, on one axis. At some remote time a separation occurred. But no force of avulsion, whether the moon was merely left behind as the mass contracted, or whether, as Mr. Darwin thinks, it was thrown off after the earth had become solid, and pushed back to its present distance, could affect the plane of rotation, or the direction of the axes. On mechanical principles, the moon when it left the earth must have moved in the plane of the earth's equator, and the three axes—that of the earth, that of the lunar orbit, and that of the moon itself—must have been parallel to each other. But such is not the case now. The axis of the moon is inclined about 1° 30′, that of its orbit 5° 9′, and that of the earth 23½°. It is evident that at some time the axes, or some of them, have undergone a change of direction. On purely mechanical principles, the change did not occur before the earth and moon separated, nor at the moment of separation, nor, in fact, at any time.

Astronomy, therefore, proves too much! It proves that the present condition is not eternal; that the earth was not created with its present oblique axes—in fact, that normally it was perpendicular to the ecliptic; and that, once in any position, it was impossible for it to become more oblique "by any force known to science." To all of which those of us who are not astronomers can only answer: "What you say may all be true, but, nevertheless, the earth's axis is inclined, and, if we can not show the cause—an inability which extends to a great many other things—our business is to discover, if we can, the time when it became inclined. It is not a question of possibilities, but of chronology."

The fact that the earth's axis has a different obliquity from that of the moon proves that a change occurred in the one or the other after their separation; and, since the moon remains so nearly in the normal position, it must have been the earth that was changed. The uniformity of biological conditions in all latitudes indicates that the present obliquity had not been attained in Archæan time, nor in Palæozoic, nor in Mesozoic, nor in the Eocene, nor in the Miocene, nor in the earlier Pliocene; then comes a blank during which the Glacial epoch came and went, and, when again the record begins to be legible, there are, for the first time in the world's history, indications of alternating seasons.*

In view of all these facts, it seems most probable that, in that blank interval, the Glacial epoch, or, more largely, between the end of the Miocene and the beginning of the Champlain, that movement occurred which gave the earth seasons, unequal days and nights, and greatly enlarged its limits of inhabitability.

It requires no argument to show that an axis nearly perpendicular would account for the otherwise inexplicable evenness of geological climate. Although the Gulf Stream, or other currents, might bend the isotherms, the temperature at any point would, with such an axis, have remained constant. The conditions as to light and actinic force would have been the same everywhere, save the variation due to greater or less latitude. All this, however, is compatible with great cold; hence it remains to inquire why the polar climate was so warm. Many theories have been advanced to solve this problem. I have neither space nor time to discuss them now, and will only say that six or seven of the earlier ones are ably treated by Searles V. Wood, Jr., in the "Geological Magazine" for September and October, 1876; also by Dr. Croll, in his "Climate and Time." Dr. Croll's own theory I have discussed at large in "The Three Climates of Geology" ("Penn Monthly," June, July, and August, 1880), and have there pointed out what seem to me insuperable objections to it.†

Professor Whitney has lately put forth another theory, attributing the early warmth to the sun itself being hotter in geological times

* There probably were zones of climate in the latter half of the Tertiary, or at least in the Pliocene, but these are quite compatible with the absence of seasons, since, with a perpendicular axis, temperature, however it might differ on different parallels, would be constant in each.

† Since writing the above I have read Professor Woeikof's article in the "American Journal of Science" for March, 1886, entitled "An Examination of Dr. Croll's Hypotheses of Geological Climates." It is a careful testing of Dr. Croll's theories by applying them to present facts, as to summer and winter variations of climate. He shows that no such differences exist as Dr. Croll's theories demand. He sums up his conclusions (page 178) as follows: "The main points on which rests, so to say, the whole fabric in its explanation of glaciation and geological climates generally—the influence of winter in aphelion and in perihelion—during high eccentricity, and the calculation of temperatures in proportion to the sun-heat received, are unfortunately fallacious." The article will well repay the student of geological climate for its careful study.

than it now is. All conclusions, however, in regard to the sun's former temperature must be hypothetical; but, if it be a gaseous body, as suggested by Professor Young, it has been growing hotter all the time it has been giving out heat.* To this, as to all other theories heretofore advanced, there lies the serious objection that they ignore the world-wide uniformity of light and actinic force, and no theory that fails here can be satisfactory.

A perpendicular axis alone does not account for the warmth in polar regions. On the contrary, with such an axis, they would receive during the year less heat than they now do, and hence Dr. Croll infers that a perpendicular axis would make the polar climate less genial. This is true, if temperature depends solely on the amount of heat received. But, as every one knows, it depends far more upon the amount retained. Green-houses and drying-houses are often uncomfortably warm when the mercury without indicates a temperature near freezing. The solar rays readily enter through the glass, and are absorbed by the floors, walls, etc., while the heat radiated back is unable to escape. Many substances possess this property, and Professor Tyndall has shown that among them are carbonic acid and aqueous vapor.

In the present state of our knowledge, it is impossible to form even an approximate estimate as to the actual amount of carbon stored in the earth's crust as graphite, coal, lignite, bitumen, petroleum, etc., but it must be many times—probably many hundred times—greater than that now remaining in the atmosphere. All these forms of carbon are directly or indirectly of vegetable origin, and hence it once existed in the form of carbonic acid. It has been said, however, that so much CO^2 was not found in the air at any one time, but that it was given out by volcanoes just about fast enough to take the place of that which was stored in the earth's crust. But, as Professor Dana remarks, volcanoes do not originate this gas; they give it out only as their fires come in contact with limestone, and this occurs but rarely now, and was still more uncommon in Palæozoic times.†

It appears, therefore, that at some remote period all the carbon which has since been a portion of animal or vegetable forms, existed as free carbonic acid, and formed a part of the then atmosphere. With the beginning of plant-life a process of elimination commenced. It continued till about the close of the Tertiary, when the amount taken out by living forms and that restored to the atmosphere by decomposition became equal—a condition which still exists.

The CO^2 is now diffused with great uniformity over the earth, and,

* For proof of this curious paradox, discovered by Mr. J. H. Lane, see "American Journal of Science," July, 1880; also, Newcomb's "Astronomy," p. 508.

† "Manual of Geology," p. 363. Some think that there has been an accretion of CO^2 from interstellar space. This appears to be too hypothetical to seriously affect the argument.

for lack of reason to the contrary, we must believe that it was equally uniform in geological times. It acted as glass does in a green-house; it retained the heat radiated from the earth's surface, and consequently caused a rise in temperature. This increased in a higher ratio the capacity of the air for water, and that in its turn aided still further in retaining the heat, and of course made the climate warmer. In this, I think, lies the secret of the warm climate in high latitudes in those early times, the otherwise cold polar regions being protected by this double "blanket." The effect of such a covering is well set forth by Professor Tyndall in "Heat considered as a Mode of Motion," pp. 405, 406. I quote only one sentence: "The removal, for a single summer night, of the aqueous vapor which covers England would be attended by the destruction of every plant which a freezing temperature could kill."

In contrast with this, I add one illustration of the temperature possible were the earth covered with a "warm blanket" equal in heat-retaining power to glass. I quote from Professor Langley's summary of work on Mount Whitney to ascertain the amount of heat the sun sends to the earth: "On the summit of Mount Whitney the temperature in a blackened copper vessel, covered by two sheets of common window-glass, rose above the boiling point. With such a vessel water could be boiled in the snow-fields of Mount Whitney by the direct solar rays."

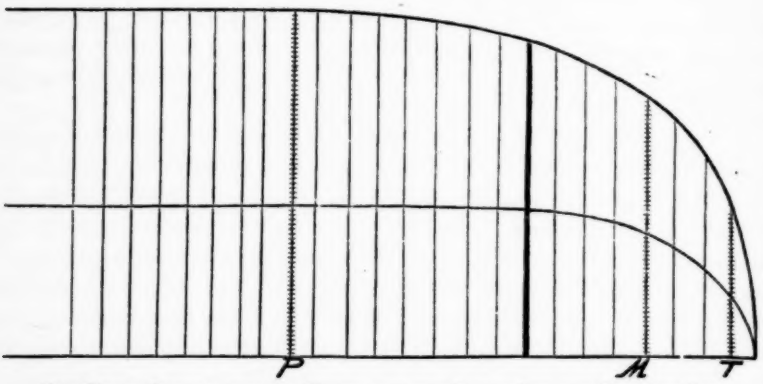
Besides carbonic acid and water, there probably were in the early atmosphere other gases and vapors. Ammonia would produce thirteen times the effect of CO^2 at the same density, and marsh-gas four and one half times, and so of others ("Heat as a Mode of Motion," p. 362). Whatever there was of these, their influence tended to increase the "warm blanket." The amazingly slow change of temperature in the early periods finds a reasonable explanation in the effect of those gases and vapors in the atmosphere.

Professor Tyndall has shown that, commencing with a vacuum, and adding a small number of very small increments, the absorption is sensibly proportional to the increments, but, as the quantity increases, the deviation from proportionality augments (idem, p. 356); at length a condition is reached in which further increments produce very little effect. The converse must also be true. Commencing with a great amount of the gas, or vapor, a very great number of decrements will be needed to produce any sensible effect; then a smaller number, and so on, until toward the end, and then the decrement needed will be very small, and the effect comparatively large.

The following diagram, made from a table on page 35 of the same work, shows this more clearly. The curved line indicates temperature for equal increments of the gas.

The diagram is for sulphuric ether and olefiant gas. All other (compound) gases and vapors observe the same law, but differ in the

rapidity of descent of the curve. The abscissæ correspond to the equal decrements in equal times; the ordinates, to the fall in heat-retaining power. Up to the heavy line, counting from the right, the ordinates are proportional to the numbers in Professor Tyndall's table (page 354), which were obtained by measurements. The others are estimated by continuing the curve to the left. If we suppose the first abscissa on the right represents the Tertiary, the next three will represent the Mesozoic; the next twelve the Palæozoic, and an unknown number beyond will represent the Archæan.



THE UPPER CURVE IS FOR THE ETHER, AND THE LOWER ONE FOR OLEFIANT GAS.

All that is known about the changes of temperature in the geological climate is derived from observing the changes in the plants and animals. These changes were world-wide, and hence were due to a world-wide cause. None sufficiently broad has been imagined other than a change of temperature, or a change in the purity of the atmosphere. The peculiar life of the Palæozoic lasted several times as long as that of the Mezosoic; and that, in turn, lasted several times as long as that of the Tertiary. Or, calling the last 1, the ratio was 12 : 3 : 1. The millions of years of the Palæozoic brought a certain increase of purity and decrease of temperature, and were followed by an almost complete extermination of species, owing to their non-adaptation to the new conditions. The Mesozoic, although only one fourth as long, brought probably quite as great a change, and was followed by "one of the most complete exterminations on record." Through the Eocene and Miocene, although not more than one fifteenth as long as the preceding, the fall of temperature was actually greater than in them all combined, and this was far exceeded in the rest of the Tertiary, for, in the Miocene, cypresses and magnolias grew within 10½° of the pole, and, at the end of the Pliocene, that dread winter began to set in which is known as the Glacial epoch. There was a correspondingly rapid change in the plants and animals. Whether it is a matter of accident, or whether they stand in relation of cause and effect, the

record of life is such as it would be if the warmth were due to a blanket of carbonic acid and water-vapor, and the temperature fell in accordance with Tyndall's law.

It is also very suggestive that, while, in the earlier periods, the changes in plants and animals were world-wide, the Tertiary changes were more and more confined to high latitudes, as if the cold were setting down from the poles toward the equator. Such was the effect to be expected if the early warmth was due to the warm blanket of CO^2 and aqueous vapor. If that was growing thinner, it would be long before any sensible effect would be produced; but, when it did appear, it would first manifest itself near the poles, where less solar heat was received, and where so much depended upon the heat being retained, and from the polar regions it would spread toward the equator. With these facts in view, there is no difficulty in seeing why the flora of temperate or even warmer regions should have had their origin in very high latitudes, since it was there that a temperature first appeared which was adapted to their needs.

I have purposely avoided speaking of how much CO^2 the air can contain and support life. I doubt very much the possibility of saying what the limits were in those remote times when not merely every species, but every genus, was exceedingly unlike any now living. They may have been adapted to conditions fatal to any creature known to us. It is certain that as the air grew purer the early animals died, and were replaced by others more like those now living. Present animals, or even human beings, according to Professor Remsen, of Johns Hopkins University, can breathe an atmosphere containing five per cent of carbonic acid "without experiencing serious or even disagreeable effects." That is, the present amount of CO^2 could be increased one hundred and fifty times, and more, without "even disagreeable effects." If this be true, the fact that the animals of those early times flourished, is no reason why we may not believe that the atmosphere contained many hundred times as much carbonic acid as it does now.

Accounting for the uniformity of biological conditions, including in that term heat, light, and actinic forces, solves only a part of the climatic problem. The cold which followed must also be accounted for, as well as the return of a mild climate to regions so long covered with ice. The former was a corollary of the causes already discussed. It was due to the combined effect of a perpendicular axis and a purer atmosphere, aided by those high latitude uplifts which occurred at or soon after the close of the Pliocene. The warm blanket being removed, the natural effects of an upright axis began to show themselves. It was the same as if the sun got no farther north than it does now on the 21st of March. Since the cold of the vernal equinox is in part the residuum of winter, it will be near the truth to say that, with the axis perpendicular, the temperature would be the same as now in April. The present flora would die out, and it would

not be necessary to go far to the north to meet perpetual snow. For snow once fallen, or ice once formed, would never melt, but, accumulating through the ages, would force its way by its own weight equatorward until it reached a region where the heat of the sun was sufficient to melt it away. The uplifts in high latitudes intensified the results. *Vice versa*, when the axis became oblique, more solar heat fell within the polar circle, those regions became warmer, and the Glacial epoch departed. If these conditions—a perpendicular axis and high uplifts—could be to-day restored, the atmosphere remaining as it is, the Glacial epoch would return.

The removal of the ice was hastened by the depression of high-latitude lands. This depression was very extensive. Vast tracts were submerged. In this is found, I think, the cause of the mild climate of the Champlain, while the cold (the minor Glacial epoch) that followed was due to another upward movement, or movements, comparatively limited in extent—in fact, confined mostly to Europe and Asia.

Subsequent changes left us the climate of to-day.

In the briefest possible space, I sum up as follows:

The uniformity of plant-life, regardless of latitude, to near the close of the Tertiary, indicates uniformity of biological conditions—i. e., of light, or actinic force, and heat.

The former indicates that the earth's axis was approximately perpendicular—a conclusion in harmony with the belief that the moon and earth were once one body, and consequently that their axes were originally parallel.

The uniformity of temperature in high latitudes through the year is also accounted for by a perpendicular axis, and, so far as I can see, only by that.

Astronomy tells only of present conditions. As to how or when the axis took its present obliquity, it is unable to say.

Geology fixes the date by the record which solar influences have left on organic forms, and places it near or just after the close of the Tertiary.

The warmth of arctic regions—for there might have been uniformity without warmth—was due to the "double blanket" of carbonic acid and aqueous vapor.

The cold of the Glacial epoch was due to the loss of CO^2 and aqueous vapor, aided by high-latitude uplifts.

The disappearance of the ice and cold was due to the earth's axis being made to incline as now, and to the reduction of the uplifts.

The warmth of the Champlain was due to depression of the land.

The second or minor ice period was due to another uplift confined to (or at least much greater in) Europe and Asia.

The depression of the land to somewhat near the present level, with present amount of CO^2 and H_2O in the atmosphere, resulted in present climatic conditions.

The influence of gases and vapors upon climate was to some extent considered by its eminent discoverer, Professor Tyndall, and I presume by every one that has read his account of his experiments on the passage of heat through these bodies. Theorizers on climate have been fond of changing the earth's axis, confining themselves, however, for the most part to altering the geographical position of the poles—i. e., increasing one set of latitudes and decreasing another, to suit their needs; and a few have invoked an increased or a decreased obliquity.

The present explanation differs widely from all that have preceded it, and in its entirety has the merit of novelty, whatever that may be.

ANIMAL AND PLANT LORE OF CHILDREN.

By Mrs. FANNY D. BERGEN.

OUR modern scientific methods of education are slowly correcting hosts of popular errors regarding every-day subjects of observation, and doubtless a succeeding generation will have outgrown many queer conceits and myths now held as facts by the great majority of country children. It will hereafter be interesting to have preserved a full record of such misapprehensions. The wish to add a trifle to such a record has led me to note some common superstitions concerning animals and plants, which have come under my own knowledge. Children have quick perceptions, and therefore are good observers or seers. The observations they make, however, regarding the animals and plants about them, while often in themselves quite accurate, lead to very incorrect conclusions. This is because children do not reason deeply. It takes a long time for them to learn that not once or twice, but a great many times, must one phenomenon follow certain other preceding phenomena to warrant the use of the logical terms *effect* and *cause*. Caution in forming deductions comes only with experience and education. Children have keen eyes for any strange peculiarities as well as for real or fancied resemblances, and are quick to appreciate the qualities of plants. An enthusiastic botanist and teacher, speaking of children, said, "They bow as to some fetich before poisonous plants." Monstrosities in Nature fascinate them. Double apples, strangely shaped knots from trees, grotesque roots, curious lichens adorn many "play-houses." Their readiness to get hold of the properties of plants explains how it is that children (boys particularly, because they are more in the out-door world) find so many things to eat in the woods and fields. A boy accustomed to tramp about will seldom go a hundred rods afield before he begins to nibble or chew something that he finds growing in his path. Can you not recall a dozen wild things of which you were fond in childhood

which long ago passed from your list of edibles? Sassafras-bark, both of twig and root, spice-wood, "slippery-elm," the buds of the linden-tree, the tender shoots from the spruce and larch, all tickle the palate of the boy or girl. Men whose boyhood was passed anywhere in Northern New England may recall how fond they once were of something which was called "sliver," the cambium layer of the white pine. In certain places it is the fashion to chew the leaves of the Antennaria, "Indian tobacco"—in others, thistle-blossoms. Will ever honey taste as sweet as did the dainty droplets taken direct from some unfortunate bumble-bee captured and dismembered by the boy seeking what he may devour? The tubers of the squirrel-corn and root-stocks of the pepper-root are sought after with a diligence deserving of a treasure. The birds are not the only harvesters of the pretty moss known as robin-wheat.

The numerous observations, then, of children, regarding the appearances and properties of plants and animals, give them a wide-spread series of premises, chiefly of a practical character, from which to draw inferences. Children are proverbial for asking questions, whose depth is often astonishing. Their eagerness to have their inquiries answered often leads them to take their own hasty, illogical inferences for correct answers, though they may really be quite absurd. Their natural credulity makes it easy for children to accept as a fact any notion once formulated; hence many of their superstitions may have arisen. Some of these are shared by ignorant people of mature years, who, intellectually speaking, are but children. Beliefs of this mythical nature vary somewhat with locality, but certain of them have become crystallized, as it were, and grown to be common property, and are as generally accepted by country boys and girls as any theological dogma among their elders.

The snake-tribe has given rise to an unusually large number of superstitions. Among peoples of every degree of civilization and of all times, from the dawn of history to the present day, some form of serpent-worship has prevailed. This is not improbably due to the air of mystery which attaches to the stealthy movements of the animal, and to the awe-inspiring effect of the bite of poisonous snakes. And, just as serpent-worship prevails most among savages to-day, so among civilized peoples, children, most of all, feel a fearful, superstitious interest in all that concerns snakes, and have invented many myths about them. In Central Ohio, when one child kills a snake, the lookers-on universally call out, "Its tail won't die till sundown." This notion, I find, is one of wide acceptation, and doubtless arises from the persistent vitality of the muscular contractility of the snake. In Southern Ohio it is now generally believed that a snake will not crawl over ash-wood; and a man over eighty years of age tells me the same belief was common in Massachusetts when he was a boy, and he thinks it is by no means yet extinct. In certain localities in Massachusetts

a reputed final cure for toothache is to bite into a living black-snake. An old saying—

> "Break your first brake,
> Kill your first snake,
> And you'll conquer all your enemies"—

is often recalled by the first snake one meets in the spring, or at sight of the earliest fern. I find few children can be persuaded that our common snakes are not "poisonous." And here and there throughout New England it is believed that the common water-adder (*Tropidonotus sipedon*) is most venomous, and that it carries "a sting in its tail"! This fictitious appendage of the adder suggests the remarkable hold that the belief in "hoop-snakes," and their extraordinary gymnastics, has obtained in many of the remoter and more heavily wooded portions of the country. This imaginary creature is said to have a sting in its tail, which, when about to make an attack, it takes in its mouth, so as to form a hoop, then it rolls along (by preference down a steep hill-side) toward the intended victim, whom it strikes in passing with its sting. I can find no foundation for belief in any such animal.

Some dozen years ago, while I was connected with a high-school in Northwestern Missouri, my pupils tried hard to convince me that "jointed snakes" were not uncommon there. I was told that, if one of these snakes were struck a sharp blow, it would quickly break into many pieces, which, being very brittle, were apt to fly about in different directions, so that it would be difficult to find all of them; but if left alone, after the danger was past, these scattered parts or "joints" would "crawl together," fall into order, and creep off as good as new. There was so much testimony concerning this marvelous reptile, that I was tempted to think there was some basis of truth for the belief in its existence, but, after minute inquiry, I concluded that the whole story had probably grown out of the fact that there is a certain lizard (*Opheosaurus ventralis*), popularly known as the "glass-snake," whose tail is so fragile that it breaks easily when struck. I find that, at least in one village in Eastern Massachusetts, the boys insist that, if you cut off the head of a certain kind of snake, it will grow on to the body again and the snake will live.

Another most absurd notion whose connection with the subject of snakes is, however, wholly nominal, is that horse-hairs, if allowed to remain in a pond or puddle of water, will become living creatures—"turn into snakes" is the technical term among boys, I believe, for the supposed metamorphosis. It would seem that, by way of teachers long before this, Professor Agassiz's article on this subject might have worked its way even into very provincial districts. Nevertheless, only last year, a young man in a thriving Western college earnestly supported the theory, and tried hard to convince his professor in zoölogy

that he had known of cow-hairs turning into short, thread-like worms. He probably had seen either young specimens of *Gordius* or some other nematode worm in the barn-yard and also seen plenty of loose hair lying about and connected the two facts as cause and effect.

From the time when there was an unwavering belief in the existence of a jewel in a toad's head and faith in its great medical virtues to the present day, a good many queer notions have been propagated about toads and frogs. Farmers' boys from Maine to Indiana are often cautious about flinging stones at either toads or frogs, lest their death should "make the cows give bloody milk." Throughout New England the killing of a barn-swallow is believed to have the same effect. East and West, North and South, the common name of our fresh-water *confervæ*, "frog-spittle," very generally bears a literal meaning to the country boy or girl as well as to many grown-up persons. The teacher in country schools will not always find it easy to convince her pupils that this floating green scum is a mass of growing plants. It is a very common belief that the tails of tadpoles literally "drop off" as might a loose finger-nail. Boys appreciate sufficiently a frog's strong hold on life to say "he has seven lives." I have met several children who thought that the fungi known as "toad-stools" derived their name from their being an actual resting-place or shelter for toads. I do not, however, know that this idea has any extended range. Speaking of toads, I wonder if the wide-spread but erroneous belief, that the touch of a toad will produce warts, first came about from the accidental discovery that the secretion of the glands of the skin is very acrid? This might easily have been guessed from the alacrity with which a dog will drop a toad if he has by chance bitten one. But is it not more likely that the fallacy regarding the production of warts is a result of some such theory as the "doctrine of signatures"? This, you remember, led physicians, in the infancy of medicine, to adopt as remedies many herbs quite destitute of curative powers merely because of some external characteristic which, so the doctrine supposed, indicated the disease to be cured by the use of the several plants thus employed. For this and no other reason the little eyebright (*Euphrasia officinalis*) was enrolled in the early materia medica as a panacea for diseases of the eye. The rough coat of the toad would naturally suggest the idea of warts, and a single suggestion very easily grows into a theory, and a theory into a belief.

Some reputed remedies for warts may be in place just here. In Southern Ohio the children believe that the juice of the Osage orange (*Maclura aurantiaca*) will remove these disagreeable excrescences. In other parts of the same State the juice of the tiny creeping "milk-weed" (*Euphorbia maculata* or *E. humistrata*) is said to be a certain cure for warts. This latter notion I also find common in many places both east and west of Ohio; while in Eastern Massachusetts the same curative quality is thought to be possessed by the milky juice of the

Asclepias cornuti. Now, does not the fact that plants which differ so widely from one another, save in the one respect of secreting a white or milk-like juice, are alike reputed to possess this power of removing warts, probably show that this virtue is entirely imaginary and the result of the accidental similarity in their juices? With or without reason, in Eastern Massachusetts it is thought that bathing warts with rain-water that chances to stand in a yellow-oak stump will cure them. Another remedy is to rub them with a bean-leaf and then hide the latter. Or, again, steal a bean, rub the warts, throw the bean on moist earth or bury it, and, as the bean sprouts, it is supposed the warts will gradually disappear. Another "cure" is to cut a notch in a sprout of an apple-tree, rub the wart across the notch, and as the notch grows up the wart will be removed.

Those who were pupils in Western district schools twenty or thirty years ago probably remember how if a child was stung by a wasp or bee the immediate cry from the playfellows was, "Get three leaves!" "Rub it with three leaves!" And forthwith three leaves were plucked from any three plants whatever, quickly crushed in the hand and held on the bee-sting, and, no matter what leaves had been found, there was perfect faith that the pain would soon be relieved.

There is a saying among young sportsmen that, to spill shot in the first load in hunting, means "no game."

Many a half-grown lad believes that virtue is imparted to the bait by rubbing it, before casting his line into the water, with the hard callosity from a horse's fore-leg; these horny growths are therefore eagerly sought about the stable or the horseshoer's shop and are carried about in the pocket in spite of their strong scent. Another supposed charm is to spit on the bait. It is just possible that some odor lent the bait by either of these substances does attract the attention of the fish, but I have no sufficient evidence of this. In some parts of New England boys dislike to meet a lone crow when going fishing, as they say this foretells bad luck. Silence is the law of good anglers (of larger growth), but boys sometimes hope to "get a bite" by repeating over and over—

> "Fishy, fishy, come bite my hook,
> I'll go captain, and you'll go cook-
> (ed in the pan)."

The confidence which children have in the various incantations which they repeat for certain purposes is most interesting. In different localities they utter various formulæ when an ant-lion's den is discovered. Children I knew years ago in Northern Ohio would quickly bend down over the little funnel in the sand and solemnly repeat in rather a loud monotone, "Mooly-up," "Mooly-up," until the sand began to be stirred by the creature concealed below, which doubtless was attracted by the crooning sound, and supposed it to be made by some

hoped-for victim. In another part of the same State the required call was—

"Jack, Jack, come up the world!
Bread and butter, bread and butter," etc.

I've rarely seen on canvas so interesting a *genre* picture as a *tableau vivant* one may often see, in Western farming districts, a child standing in the burning summer sun, holding securely with one hand a grasshopper, while he earnestly repeats—

"Spit, spit tobacco-juice!
Spit, spit tobacco-juice!"—

and the established rule of the children is to detain the queer, awkward little captive until as a ransom he "spits," when he is to go free. In New England these lines to the grasshopper are—

"Grasshopper, grasshopper gray,
Give me some molasses,
Or I'll cut off your head
And throw you away!"

I suppose every one knows the familiar call to the lady-bug whenever one is seen by a child—

"Lady-bug, lady-bug, fly away home,
Your house is on fire and your children will burn!"

I have wondered if this is merely a putting into words the idea of flame which is suddenly suggested by the sight of one of these beautifully colored beetles. What child can resist pulling a seed-dandelion and blowing the feathered head, "to see if my mother wants me to go home"? And plenty of children believe that holding a buttercup under the chin really indicates whether one likes butter or not. Many a little country girl thinks that the color of her next new dress is foretold by the color of the first butterfly she sees in the spring. In some places in Western States there is a superstition that, if you make a wish the first time you see a new-born calf, your wish "will come true."

One of the queerest myths regarding animals I learned from a native of Portsmouth, New Hampshire. The boys there, fifty or sixty years ago, were quite certain that, if a live coal were put on a turtle's back, the animal would come out of his shell and crawl away, leaving the latter behind him!

In some parts of Eastern Massachusetts if the children see a "daddy-long-legs," they exclaim, "Don't kill him, or it'll rain to-morrow!" In the same localities there is great faith in the good fortune brought by the capture of what they call "lucky-bugs"—the common whirligigs (*Gyrinidæ*), insects of an oval shape and blue-black color, which may be seen in swarms whirling ceaselessly about with a sort of waving motion on our ponds and streams. The notion is that if you can catch

one of these busy little fellows, bury him and make a wish, you will certainly "get your wish." I do not know how general is the belief that it is ill-luck to kill a spider or a cricket, but several persons have told me of this. As far as I can learn it is quite universal for children to feel that there is something uncanny about the dragon-fly. The common doubt and fear of the insect is vividly expressed by the child's name, "devil's darning-needle," so generally given it. It is usually thought to possess a poisonous sting, and in some places the belief is held that this winged needle will "sew one's ears together" if opportunity permit. In some localities in New England another superstition, indicated by the common name of the creature, is that there is danger that the earwig will creep into the human ear and eat out one's brains. An equally absurd and ungrounded fancy is that the mole regularly comes out of his burrow every day for a few moments at just twelve o'clock.

I have found in both Eastern and Western Massachusetts that children are fond of eating what they call "swamp-apples." This "fruit," upon investigation, turns out to be an excrescence, very frequently occurring on the *Azalea*, which is caused by the sting of an insect. One young girl told me, after I had ruined her appetite for the woodland delicacy, of which she had been very fond, that she "had thought it strange that the fruit always appeared on the plant before the flowers." "Oak-apples" or "oak-balls," the galls so frequently found on oaks, are also very often believed to be true fruits.

Many years ago in Northern Ohio I remember that among the wild flowers we children most highly prized, I suppose because comparatively rare, was one of the orchids, probably the putty-root (*Aplectrum hyemale*), which we called "Adam and Eve." Whenever this beautiful plant was found, the children at once began to look about for "the devil," as they called a third leaf, which frequently was found near by, and which was probably a new plantlet sent up by the creeping root-stock beyond the older portion of the plant.

I do not know how general is the very queer notion that an apple-sprout, planted upside-down, will produce a tree that will bear apples without any core.

In various parts of New England, when roast goose is served for dinner during the autumn or early winter, the children are eager to examine the breast-bone to see what sort of a season is foretold. If the bone be mostly dark, it is said to signify a rainy winter; but if the bone be mainly white or light-colored, then much snow is to be expected. Another New England superstition concerning geese is that wild ones in their changes of position while on the wing form the various letters of the alphabet.

As a remedy for the disease prevalent among young chickens, commonly known as "the gapes," children, as well as grown-up people, in some parts of the West, remove the little scale that is found on the

end of the bill of a newly hatched chick. It would be of more practical value did they know that the real cause was a little thread-like worm far back in the throat. This worm may easily be removed by a loop of horse-hair, or destroyed by the application of proper remedies. In the same localities I remember that when I was a child "luck-eggs," as we called the very small eggs, now and then dropped at the end of the laying-season, were highly valued by children, as they believed that so long as one of these small treasures was kept unbroken good fortune would attend the possessor. Children in some parts of New England have a very singular notion that it is the yelk of the egg which, during the process of incubation, develops into the body of the chick, while the white gives rise to the feathers. With this instance I may close the present brief account of such specimens of the animal and plant lore of children as a moderate amount of inquiry has enabled me to procure. I have mentioned approximately the regions where I knew the various superstitions were entertained, but doubtless many of them have wider range than has here been indicated. More extended research, particularly in out-of-the-way localities in the South and West, may greatly add to the list of such beliefs.

NOTE.—The writer will gratefully acknowledge the receipt of additional myths of similar character to those here given, with a view to subsequent fuller treatment of the subject. Beliefs of adults will be acceptable, as well as those held only by children, and it will be of service if considerable detail be given in regard to the geographical or social boundaries of the superstition, and if the latter be stated as explicitly as possible. Address Mrs. Fanny D. Bergen, P. O. box 253, Peabody, Massachusetts.

THE ORIGIN AND STRUCTURE OF METEORITES.

BY M. A. DAUBRÉE.

TILL the second half of this century the nature of the innumerable stars with which space is peopled was wholly a subject of imaginative speculation. Recent science has been able to substitute more exact ideas for premature hypotheses. Notwithstanding the immense distances that separate them from us, spectrum analysis has enabled us to make chemical investigations of the sun, the comets, stars, and nebulæ. It is, further, possible to reach results more precise and more complete in other respects for many extra-terrestrial bodies; that is, for those bodies, fragments of which are dropped from time to time upon our globe. Although we have no means of going to them, they come to us, real messengers from above, to satisfy our legitimate curiosity. The study of these fragments, the only cosmic bodies which it is possible for us to handle immediately, concerns one of the fundamental questions of the physical history of the universe.

The list of meteors, both in ancient and modern times, is very full.

Some of the more remarkable falls were objects of extraordinary attention among the inquisitive but imperfectly informed ancients, and the stones themselves were invested with something like divine honors. But, notwithstanding the frequent and authentic testimonials that were given of the fall of meteoric bodies upon the earth in the course of more than twenty centuries, educated people were still incredulous on the subject not more than a hundred years ago. Inversely to the usual course, even the advance of knowledge furnished objections against the truth. The most natural supposition of an extra-terrestrial origin of the meteors appeared to contradict the immutable laws of the movements of the heavenly bodies; for those laws seemed to be inconsistent with the possibility of irregular phenomena. It was easier to deny the reality of such anomalies than to believe in them. But it will not be right to give too severe a condemnation to this persistent denial; for the fabulous and fanciful details with which the accounts of the phenomena were charged necessarily gave an air of incredibility to the whole. It was not till the end of the last century that conditions especially favorable to exact observations afforded the means of unanswerably demonstrating the existence of meteors. The recognition of them became general and complete after the showers that occurred at Benares, India, at eight o'clock in the evening of the 13th of December, 1798, in the presence of a large number of spectators; and was further strengthened after the fall at L'Aigle, France, at one o'clock in the afternoon of the 26th of April, 1803. Biot, acting under a commission of the Academy of Sciences, made a minute account of all the circumstances of the last fall.

Meteorites interest us not only in respect to the origin and the causes of their descent upon our planet, but also in respect to their constitution. It is to the last aspect that we shall pay particular attention, after giving a succinct account of the circumstances under which they come to us.

The phenomena that precede and accompany falls of meteorites, while they vary very much in their secondary details, nevertheless present a whole of general character, reoccurring with constancy at each apparition, and adequately proving that the origin of the bodies is foreign to our planet.

The first appearance is that of a globe of fire bright enough to set all the atmosphere aglow at night, or to be visible at high noon, if in the daytime. Its apparent diameter increases as it gets nearer. It describes a track whose incandescence makes it perceptible from a distance, and which is only slightly inclined to the horizon. The cosmic character of the bodies is indicated by their excessive velocity, which surpasses anything that we know of on the earth, and is in reality comparable to that of the planetary bodies. After a longer or shorter career, the body bursts with a noise which has been compared with that of thunder, a cannon, or musketry, according to the distance away

of the observer. A single explosion is rare. There are generally two or three of them. Sometimes they are violent enough to shake houses and give the impression of an earthquake, as was the case in Iowa when the meteor of the 12th of February, 1875, fell. They are often heard over a considerable extent of country, as was the case with the Orgueil meteors, the explosions of which were heard three hundred miles away. When we reflect that these detonations take place at heights where the thinly rarefied air affords a very poor medium for the propagation of sound, we become satisfied that they must be extremely violent. Sometimes a trail of vapors is perceived in the regions of the atmosphere which the body has traversed. These phenomena are manifested in the most diverse regions of the globe, at every season and every hour, and frequently in calm and cloudless weather. Storms and whirlwinds, therefore, have nothing to do with them. Their speed as observed by us being only relative, varies according to the correspondence or non-correspondence of the direction of their path with the course which the earth is pursuing.

The outer configuration of meteorites is remarkable for its fragmentary aspect, or for its angular formations and its likeness to irregular polyhedrons, the edges of which have been blunted.

The number of stones brought down in a single meteoric shower is extremely variable. Sometimes only one is found; sometimes many; and, in rare cases, hundreds and thousands. At the instant the stones reach us their velocity is small, compared with that which the body of which they are fragments had previous to the explosion. If they are of considerable size, they will perhaps bury themselves at a slight depth under a yielding soil, and remain there unperceived. After all the light they give and the noise they make in their flight, the minuteness of the masses which we find upon the surface of the ground is sometimes surprising. The largest one ever found—at St. Catherine, Brazil, 1875—weighed 25,000 kilogrammes; stones of more than 300 kilogrammes, like the one that fell at New Concord on the 1st of May, 1860, are rare, while the weight of 50 kilogrammes is seldom exceeded. Often whole meteorites weigh only a few grammes, or are of the size of a hen's egg, a walnut, or a hazel-nut; and masses of still smaller ones have been observed when they fell upon a bed of snow, as at Hersle, near Upsala, Sweden, in 1869, when many of the stones weighed only a few decigrammes, and one of them as little as six centigrammes. These little grains, it should be remarked, were not fragments broken off by the shock of larger pieces against the ground; but each one was a complete meteorite, enveloped in a crust of half-melted matter. That so small meteors had not been noticed before is explained by the difficulty of distinguishing them from the particles composing the general surface, among which they are lost.

When the meteors of the same shower are numerous, they are generally distributed at various points within an elongated oval area, the

axis of which corresponds with the direction of the trajectory, and within which they appear to have been sifted by the resistance offered by the atmosphere, in the order of their magnitude.

Meteors are not incandescent when they reach the ground, but are still too hot to handle. Sometimes the high temperature is limited to their surface, while within they are extraordinarily cold. The spectators of a meteoric fall at Dhurmsalla, India, on the 14th of July, 1860, eagerly broke up the stones, still burning hot on the outside, and were greatly surprised to find that it was impossible to handle the inside parts on account of their extreme coldness. A similar observation was made on the 16th of May, 1883, at Alfianello, near Brescia. This contrast between the central part, still retaining the intense cold of the planetary spaces, and the outside, which only a few moments before had been red-hot, may be easily understood when we reflect on the feebleness of the conducting powers of stony substances, and the very short time that they had been heated.

One effect of this heat persists, and is obvious at first sight as a general characteristic of meteorites, in the shape of a black crust, entirely covering them. It is not a millimetre thick, and is generally dead, but forms in some especially fusible types a glossy enamel. The same effect, of vitrification, is produced by lightning on rocks which are struck by it. The incandescence of which this is the effect, and which had been observed in the meteor flying in the distance, is the result of the extreme speed with which the body penetrates the atmosphere.

It is, unfortunately, very rarely possible to find the fragments projected by meteors; and it is only under quite exceptional circumstances, even in populous countries, that one is discovered among the clods and under the vegetation by which they are commonly concealed. The observer enjoys the illusion of supposing he sees them fall at no great distance from him; but he will hardly ever find one if he looks for it. Probably three quarters of them are swallowed up by the sea.

Supposing there are three meteoric showers a year in Europe—and this is the mean of what has been observed there—and that that part of the earth is not exceptionally favored by them, we have one hundred and eighty a year for the whole surface of the globe. But, as many of the showers are not perceived, we may safely triple the figure, or even suppose there are six hundred, and still underestimate the reality. We are dealing, therefore, with a daily phenomenon.

We do not know in what regions of space meteors originate, nor what courses they follow before they come within the sphere of the earth's attraction. They have been supposed to be ejections from volcanoes in the moon. If this were the case, they would have to be supposed to have been ejected by the eruption with velocity enough to pass the neutral point, or the point where a body is equally attracted

by the moon and the earth. That velocity should be at least 2,270 metres a second, or about five times that of a cannon-ball; if it were less, the mass would fall back to the moon. Another more probable supposition is that they come from a group of minute asteroids which revolve in the space between Mars and Jupiter, whose orbits cross those of the large planets, ours included, and are occasionally met by the earth in its course. There is nothing else, since the beautiful researches of Schiaparelli have connected the periodical swarms of shooting-stars with comets, to assure us that they do not come from still more distant parts of the sky, or even from without the solar system.

Shooting-stars come to us by millions at regular periods; and the number of those which are directed toward our globe in a single year is estimated at many milliards. They somewhat resemble meteorites in the abruptness of their appearance in our atmosphere and the excessive rapidity of their motion, but they differ from them in an important characteristic. None of them ever reach the ground. They appear to share in the properties of comets, from which they may have been dismembered and told off by perturbing actions; while meteorites seem to be related to the planets. The difference between them is like the difference between gases or vapors and solid bodies.

The meteors coming to our earth without, excepting as to their superficial vitrification, undergoing any change, we are able, by subjecting them to analysis, to derive from them some precise facts respecting the constitution of the bodies in space. The first fact, which comes out from hundreds of analyses, is, that they have not brought a single substance which is foreign to our globe. About twenty-two elements, all known to the chemistry of the earth, have been recognized as present in them. Among these, iron, silicon, magnesium, nickel, sulphur, phosphorus, and carbon, are the most important. While they are all clad externally in a common livery, meteorites, when examined in their fractured parts, along with traits of similarity, present considerable differences. They have been classified, according to their types, into four groups, according to the proportion of iron they contained. Those of the first group are composed almost wholly of iron, which is known as meteoric iron. It is always alloyed with nickel and a few other metals, and contains carbon free or in combination, as in steel, with frequently sulphuret and phosphuret of iron in scattered globules and grains. It is always recognizable by a single peculiarity in its structure. If we moisten a polished surface of it with an acid, we shall immediately observe the appearance of numerous straight lines, as fine and as true in their parallelism as if made with an engraver's tool, and crossing one another in a net-work of regular geometrical figures. These designs, called the figures of Widmanstaetten, after the first observer of them, result from the fact that the metal is not of homogeneous constitution. It is composed of two alloys of iron and nickel, in a crystalline condition, one of which, not

being affected by the acid, stands out in relief from the other, which is attacked by it. The meteorites of this group are called *holosiderites*, or all iron, in distinction from the others, which contain also stony matters. They are vastly more rare than those of the other groups. The stony substances of the other groups consist chiefly of silica in combination with magnesia and peroxide of iron, as peridote or pyroxene. If these silicates are in small proportion and thinly scattered through the iron, they are *syssiderites;* if it is the iron that is in relatively small proportion and appearing only in isolated grains, they are *sporadosiderites.* In other meteorites, comparatively few in number, no metallic iron can be perceived, and they are called *asiderites.* The most interesting specimens among them are remarked by their dull-black color, and a general appearance like that of peat or lignite. Besides stony matters, they contain carbon in combination with hydrogen and oxygen—a chemical quality which has led to their being examined for remains of organic beings. But no trace of anything of the kind has been discovered. They also have escaped all alteration by heat beyond the superficial glazing, and thus strengthen the evidence that their origin is exterior to our globe.

Among all the diversities presented by the specimens of more than four hundred meteoric showers, is the remarkable fact that meteorites which have fallen at the most distant epochs, and in countries most remote from one another, not only conform to the same type, but present so complete an identity that their respective fragments can not be distinguished even upon a close mineralogical examination. Nothing in the exterior form of meteorites is more striking than a general aspect indicating that they are parts of a broken body. When we compare hundreds or thousands of stones of the same fall, we find that they all present polyhedral forms like those of stones broken for a macadamized road, except that the angles are more or less rounded. Even meteoric iron exhibits this angular shape, showing that its malleability and extreme tenacity have not preserved it from a violent rupture. It seemed impossible that such an effect could be produced solely by the action of the air, especially in the upper regions where it is in an extremely rarefied condition. But light has been thrown upon the problem since the introduction of the new explosives, which illustrate, in their industrial applications, the prodigious force that gases are capable of exerting, even in small quantity, when they are suddenly animated by a considerable tension. The explosion of a kilogramme of dynamite will break up bars of steel which a pressure of a million kilogrammes would hardly crack. Similar conditions concur in the upper strata of the atmosphere, slight as their density may be, when a meteor moving with planetary velocity strikes upon them. The body compresses the air more rapidly than it can yield, and transmits an equivalent motion to its own molecules. Under these circumstances, in the successive detonations caused by an enforced rotation, iron and the

most tenacious bodies will fly into pieces, as if they were struck with a pile-driver.

There is another no less characteristic feature of the surface of meteorites which testifies to the violence of the mechanical action produced upon them by the atmospheric rebound, exhibited by rounded cavities resembling finger-marks. They appear in the stony meteors, but are particularly characteristic of the iron masses. These marks were at one time attributed to transient explosions taking place during the course of the meteor through the air; but experiment has shown that the same appearance is produced in bodies which are acted upon by an explosion of dynamite; in the grains of coarse powder that drop, half consumed, from the mouth of a cannon when it is fired, and upon the touch-hole of the cannon. They are all due to the same cause—to the erosive action of gas revolving rapidly and moving spirally and under high pressure against the projectiles, boring into them as if it were a gimlet. The mechanical action is accompanied and aided by a chemical action which is dependent upon the combustible nature of iron at high temperatures. Although these blister-holes are worked only on the face which is exposed to the direct pressure of the gas, meteorites present them on various sides, and sometimes over their whole surface. This arises from the rotatory character of the motion of the body which makes it present every side in succession to the front.

With these mechanical phenomena of meteorites is connected the coming to the earth of dusts of celestial origin. In examining these, we must first be careful to separate the earthly dusts, with which the air is more or less loaded, of every kind, natural and artificial, from volcanoes and from waste tracts of the earth's surface, mineral, vegetable, and animal. These are recognizable by careful examination; and, after they are all detected, there remain still other dusts, which incontestably come to us from regions foreign to our globe. The carbonaceous meteorites of Orgueil furnish us a very interesting prime document respecting them. These bodies are so friable that they are reduced to powder under the slightest pressure of the fingers, and they would probably have been pulverized in their course through the air if they had not been protected by their heat-formed crust. Further, when aërolithes of this species are moistened with a little water, they are completely disaggregated and reduced to extremely fine particles in consequence of the solution of the alkaline salts which perform to them the part of a cement. Under this property, if it had been raining when the Orgueil meteorites fell, on the 14th of May, 1864, or if they had had to pass through a stratum of cloud, they would have been dissolved in their course, and all we should have found of them would have been a little black slime on the ground.

Extra-terrestrial dusts usually reach us under quite different circumstances, and without the intervention of water. The meteoric

stones as they pass through the air are followed by a tail which, at first bright, soon blends itself with the darkness, like the smoke of a piece of fire-works. It keeps the direction of the path of the meteor for a longer or shorter time, and is undoubtedly composed of particles which have become detached from the body, and remain suspended in the atmosphere till they are scattered by the winds. The mode of the action by which this dust is rubbed or blown off is explained by the experiments I have made with explosive gases in the investigation of the origin of the blister-holes of meteorites. Masses of gas at enormous pressures almost instantaneously pulverize whatever bodies they strike, and this is precisely what happens to the meteoric stones as they pass through the air. Judging from the thickness of the clouds following the bodies and the space they occupy, we conclude that they furnish considerable quantities of metallic and rock-dusts to our atmosphere.

A careful investigation of the dusts which may be supposed to be of cosmic origin is very desirable, as also is a systematic examination of the atmosphere by all the means in our possession, after every explosion of a meteor, for that which they may have left. Something has been done in this direction by Mr. Phipson, M. Nordenskiöld, and M. Gaston Tissandier. Doubtless the shooting-stars, extreme as their tenuity may be, also bring down ponderable substances in minutely divided condition. The spectroscopic examination of these asteroids by Mr. Alexander Herschel has revealed the presence in them of sodium, magnesium, carbon, and other bodies. The fact is confirmed by the formation, in connection with the extraordinary meteoric shower of the 27th of November last, of a cloud of vapors which obscured all the stars except those of the first three magnitudes, and was shortly afterward dissipated.

The question, whether gaseous and invisible substances may not also be introduced to the earth from the realms of space, can not yet be answered from observation.

The most interesting resemblances, and even identities, are occasionally revealed between the meteorites and some of the deeper rocks of our planet.

Volcanoes bring up daily, besides prodigious quantities of vapor of water and gaseous products, melted, intensely hot stony matters, which spread upon their flanks and are known as lavas. During the ancient periods, there came out also, from the depths below the granite, rocks of a nature very different from that of the stratified rocks, and presenting an analogy with the lavas. They occur on the surface in various forms of sheets, cones, and irregular masses. Below it, they constitute, in the thickness of the incasing rocks, a kind of columns, which are connected with the extremely deep reservoirs from which they have been thrown up; they have in fact been thrust here and there in consequence of eruptions, through the superposed masses, far

from their original bed. Like the lavas, they are composed chiefly of silicates.

We observe, in the first place, that most of the eruptive rocks differ considerably from meteorites. The most important point of contrast is that the latter contain nothing resembling the arenaceous or fossiliferous matters of which the stratified beds are constituted—that is, nothing suggesting the action and movement of an ocean or the presence of life. A great difference also appears in comparison with the masses on which the sedimentary beds immediately rest. Thus, we never find granite, or any of the minerals associated in it, in meteorites. The analogies of meteorites must be sought in the silicate rocks, which originate in deep regions, below the granite.

A striking example of this similitude is afforded by the recent lavas, which are formed from the association of two silicates, pyroxene and anorthite feldspar, and which correspond exactly with the meteorite picked up at Jonzac (Charente-Inférieure) on the 15th of June, 1819, and with that one which fell at Juvinas, in the department of Ardèche, on the 13th of June, 1821. Peridote, which is remarkably constant in meteorites, also occurs in the eruptive masses, often abundantly.

An equally remarkable fact is the absence from meteorites of the whole series of rocks which form an important part of the crust of the globe. It may be explained by supposing that the meteoric stones that reach us come exclusively from the internal parts of planetary bodies constituted as our globe is, or that those bodies are destitute of quartziferous silicates, like granite, as well as of the stratified beds. In the latter case, those stars have suffered less complete revolutions than our planet, and exhibit no traces of the co-operation of an ocean by which most of the crust of the earth above the internal masses has received its shaping.

A recent unexpected discovery, made by M. Nordenskiöld in Greenland, has shown the resemblances we have just described to be closer and more complete. It is worthy of remark that, notwithstanding the abundance with which iron is diffused in all parts of the crust of the earth, that metal has never been found in the native state. However pure and rich may be the mineral, some kind of a process is necessary to extract the metal contained in it. This peculiarity is due to the sensitiveness of iron in the presence of chemical agents, particularly of oxygen. Sir John Ross brought back from his arctic voyage, in 1818, some knives with blades formed of pieces of iron which the Esquimaux said came from scattered blocks not far from Cape York. The analysis of this iron showing the presence of nickel, a meteoric origin was attributed to it. Other samples of iron, offering similar characteristics, were brought down from the North by other explorers. M. Nordenskiöld's attention was attracted to some of these specimens, which had been deposited in the museum at Copenhagan, and prompted

him to endeavor to ascertain their origin during his voyage to Northern Greenland in 1870. After much searching, with the aid of what directions the natives could give him, he at last found the object of his investigations in the hill of Blaafjeld, or Ovifak, near Disco Island. Blocks of iron were lying on the shore at the foot of a high cliff composed of basalt and conglomerates of the same rock in alternation; and more than twenty masses, containing not less than twenty-one thousand kilogrammes of metallic iron, were collected within a small space. They were at first supposed to be of meteoric origin, because they contained nickel, and exhibited figures which had been regarded as peculiar to meteoric iron. But this view was proved to be incorrect when M. Steenstrup, under a commission from the Danish Government to investigate the conditions under which the iron occurred, found, at one point on the coast, native iron actually imbedded in the basaltic rocks, the appearance of the larger grains of which was precisely similar to that of the scattered blocks previously found. The presence, in the eruptive rocks of the earth, of iron alloyed with nickel, similar to meteoric iron, and having the crystalline texture which had previously appeared to be an exclusive characteristic of the latter, has therefore become incontestable. It is proper to add that the metal in this condition is not a fortuitous and isolated accident in Greenland, but that it is found in many places and over considerable districts.

The geological structure of the northern part of that country is especially distinguished by the development of eruptive rocks of a relatively very recent age. It is one of the largest masses of basalt with which we are acquainted. It begins at the sixty-ninth degree of latitude, and disappears near the seventy-sixth degree, under the vast continental glacier which prevents all further exploration of the surface. It is reasonable to suppose that the eruptions of which these rocks are the result brought up metallic iron, of which they seem to indicate the existence of large masses in the deep interior. This fact has also to be taken account of in the theory of terrestrial magnetism.

After having sketched, twenty years ago, the numerous features of resemblance between the meteorites and the deep terrestrial rocks, and having shown how some of them can be imitated by a partial deoxidation of those rocks, I added: "There is nothing to prove that beneath those aluminiferous masses which have furnished, in Iceland, for example, lavas analogous to the meteorites of Juvinas, that beneath our peridotic rocks which the meteorite of Chassigny closely resembles, there may not be found masses in which native iron begins to appear, or resembling meteorites of the common type; then, below these, types richer and richer in iron, of which the meteorites offer a series of increasing density, from those in which iron represents nearly half the weight of the rock to massive iron." Five years after these lines were written, the great masses of native iron alloyed with nickel,

of which we have just spoken, were discovered by M. Nordenskiöld. The discussions upon their origin, which we hesitated at first to regard as terrestrial, sufficed to bring out the close analogies between them and the meteorites. The study of the latter bodies has, then, permitted us to penetrate by induction into the internal constitution of our globe, as if by a side-look into depths wholly inaccessible to direct observation. The last demarkation has thus been effaced, and a most intimate connection has been established between the masses thrown up from the interior of our planet and the celestial masses of which the meteorites bring us the fragments.

The analogies which we have pointed out between meteorites and the profound regions of our globe testify to the identity of the chemical actions, even in the formation of stars very distant from each other. In fact, a mineral generally suggests, in a precise manner, the circumstances under which it originated. We might say that in itself it tells the story of its origin, especially when it can be reproduced experimentally. We thus perceive how reason, assisted by experiment, can give us clews to the formation of the stars of which we possess fragments. Silica or silicic acid is a chemical agent, the energy of which becomes very considerable at high temperatures; it is also the characteristic element of numerous products formed in industrial furnaces, like glass, scoriæ, and slags, and of the lavas of volcanoes. All the silicates, artificial and natural, when free from water, or in the anhydrous state, denote the dominance of a high temperature over their formation.

Suppose that silicon and the metals were not originally combined with oxygen as they are now, either because the different elements were not near enough together in the primordial chaos, or their temperature was not high enough to permit them to enter into combination. When oxygen comes into action, it unites at first with the elements for which it has a predominant affinity, primarily silicon and magnesium, then iron and nickel; and, if the gas is not in excess, it leaves a residue composed of the less oxidable bodies. Iron and nickel would in that case be left in a free state, disseminated among the stony silicates. This is exactly what is observed in the meteorites; and it is also a fact which I have confirmed by experiment. By producing the conditions that have just been mentioned, I obtained an imitation in essential points of meteorites of the common type, with the production of a silicate of magnesia and protoxide of iron, having exactly the constitution of peridote.

Furthermore, one of the best-known every-day metallurgical operations, the decarbonization of cast-iron, or its transformation into malleable iron or steel, gives an analogous reaction and ends in a result of the same kind. Whether the process be carried on in little charcoal-furnaces, as in antiquity, or in puddling-furnaces, or, as by the Bessemer process, without the addition of any combustible, it is always the

oxygen of the air which burns, not only the charcoal, but also the silicon in the pig and a part of the iron. The black scoria which is formed in the process often contains a peridote with a base of iron, having the same chemical constitution and crystalline form as the magnesian peridote of the eruptive rocks of the earth and of the meteorites.

The simple oxidation of silicon develops an enormous quantity of heat, very much more than the combustion of carbon; a heat which is sufficient to refine the metal in the retorts of iron and steel works without the addition of carbon. Silicon, which in nature has passed wholly into the state of silicic acid, or been burned, must, at the moment of its combination with oxygen, have been the cause of an intense heating both in our own globe and in the other stars, which are also composed of silicates. But in the last, of which meteorites are the fragments, the temperature was not probably so high as in the metallurgical furnaces and the experiments we have cited. It is, in fact, very remarkable that, notwithstanding their tendency to a distinct crystallization, the silicate compounds of which the meteorites are constituted are only in the condition of very small and quite confused crystals, as if they had not passed through fusion. We might say that, rather than the long needles of ice which liquid water forms in freezing, their fine-grained texture resembles that of frost and snow, which is known to be due to the immediate passage of atmospheric aqueous vapor to the solid state.

In brief, the extreme tendency of the oxidation of silicon to produce the formation of peridote, daily proved in our laboratories and shops, is no less evidently manifested in the deeper rocks of our globe, on the one side, and in the distant stars from which the meteorites come, on the other side. Everywhere are observed the effects of an ancient and vast oxidation. In this we have a simple and experimental explanation of the ubiquity of peridote. It is the universal scoria.

As a forest shows at a glance the plant-life of all ages, the universe presents us stars in all the phases of their existence, from that of incandescent heat to obscurity, and an advanced cooling. We have also just seen that some of them are in demolition, and that their fragments fall upon others, to which they remain attached. The numerous falls of meteorites on our globe teach us that this fact, instead of being an exception, answers to an habitual *régime*. And the constitution of the meteoric masses teaches us with certainty that the celestial bodies whence they emanate have a chemical history quite similar to that of the interior regions of our planet.

So, while the exploration of the sky reveals to us millions of worlds beyond our solar system, our planet, small as it is, offers us an example of the changes which the stars have undergone, and an episode in the general history of the universe. The meteorites form a kind of line of union between the succession of the epochs of the earth, the object

of geological study, and the constitution of the sky, the aim of astronomical research. These two parts of human knowledge reflect complementary lights upon one another.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE CARE OF THE BRAIN.

By Professor AMBROSE L. RANNEY, M. D.

THERE is a natural tendency on the part of most parents to aim at precocity in their first child. They love to boast of its progress, and to draw favorable comparisons between it and the children of friends. Sometimes, as we all know, they overdo the matter, and produce a mental deformity, or a mental dwarf, or an idiot, or a grave in which their hopes as well as their error are buried.

No question is more difficult for a parent to decide than this: "When and how shall I begin to train the mind of my child?"

Unfortunately, the advice of teachers or physicians upon this topic is not always the same. Some answer such a question hastily; some from preconceived opinions that are not always free from bias. Others, again, fail to investigate, before answering, the hereditary tendencies of the child, whose future they are called upon to be instrumental in molding. Finally, most teachers and some of the medical fraternity are more or less ignorant themselves of the later discoveries made in cerebral physiology, and are therefore not always well fitted to be advisers respecting the best means to develop the organ of the mind properly.

The human brain is more wonderful and delicate in its construction than any invention of man. Few of those who have children seem to appreciate the care that should properly be exercised in promoting its natural growth and the best development of that organ—especially during the early years of life.

Parents who watch with anxiety against the possibility of bodily deformities in their children are often unaware of the harm that may be done to young brains by ignorance or neglect on the part of those who have them in charge. They know nothing themselves of the organ of the mind, but they think themselves justified in believing that a system of training which has produced good results in some children is applicable to each and every one.

Now, it should be remembered that minds, like faces, are not cast by Nature in the same mold. The quality of workmanship and the material is finer, so to speak, in some brains than in others. Some children are congenitally predisposed to nervous excitability or debility. Certain of the component parts of the brain become perfected during their development before others. Some of these parts are capable of

acquirement from the moment of birth, while others are not called into play for many months afterward.

I have known many a child to be crowded prematurely to a point in mental development that has either arrested further growth of the intellectual faculties or caused its death indirectly.

Hardly a month passes in which I am not compelled to urge parents (often against their inclinations) to modify or discontinue some defective system of mental training of their children. Many cases of idiocy, epilepsy, St. Vitus's dance, dropsy of the brain, and other nervous diseases of childhood encountered by physicians, might have been prevented if the parents had been made intelligent respecting the dangers that encompassed the child, and used proper precautions against them.

Within the past decade, the functions of different parts of the brain have been determined with an approach to scientific precision. We are now able to trace (by methods lately discovered) the course and terminations of separate nerve-bundles which compose the bulk of the brain. Pathology has helped us to verify, in the case of man, the deductions drawn from experiments upon the brains of animals. The microscope has enabled us, furthermore, to detect structural differences between various groups of brain-cells, whose functions have been shown to be totally distinct from each other.

These and other discoveries (too numerous to mention here) have a practical value as well as a scientific one. They afford us many hints which may be applied during life. They aid us materially also in preventing as well as relieving diseased conditions of the wonderfully constructed mechanism.

These are the few physiological facts which I am particularly desirous of impressing upon the reader, since they form a basis for my conclusions. These may be summarized as follows :*

1. Different areas of the surface of the brain have functions *peculiarly and exclusively their own.* Thus the brain's surface may be likened to a map with its various territories, each of which is at times perfectly independent of the other in respect to its functions, but still capable of concerted action with the rest when such action is required. We recognize as distinctly defined those areas, for example, which preside over motions, sight, smell, taste, touch, hearing, general sensibility, and some others.

2. Each of these areas of the brain-surface has to be *separately educated.* The memories connected with past experiences are stored within the cells of the area which appreciates the facts as they occur.

3. Some parts of the brain *develop more rapidly than others.*

4. The education of some parts of the organ consists chiefly of the

* There are certain anatomical and physiological facts respecting the human brain to which the attention of the reader could be directed with benefit before the practical part of this subject is discussed. To those who are interested in this field, I would refer

acquisition of memories of such things as the part in question has been specially designed to appreciate. This is particularly true of the parts related to vision, hearing, smell, taste, touch, etc.

5. The *higher mental faculties*, such as judgment, reason, self-control, etc., require the *concerted action of different parts* of the brain's surface. This is because all such acts are based, of necessity, upon our recollections of past events. These recollections may have been acquired by the aid of sight, hearing, general sensibility, smell, etc.

6. The cells of different areas of the brain do not exhibit in individuals the *same aptitude for the acquisition of knowledge*—some people remembering most easily what they see, others what they hear, others what they handle, etc.

7. In case some parts are deprived of their functions, other parts are *rendered vicariously more active*. We see this illustrated in the extreme sensitiveness of the ear and touch in the blind.

8. *Prolonged disease of any part of the brain* may cause a wasting-process (atrophy) within the brain-cells of that part.

With these deductions as a basis, we are prepared to discuss intelligently what may be regarded, in the light of existing science, as our guides toward promoting the best welfare and growth of this important organ. The views which I shall advance here are based upon the physiological facts enumerated. These have been satisfactorily demonstrated within the past decade.

In the first place, I would raise my voice in strong protest against the popular fallacy that every child, who presents no apparent deformity of limb or evidence of physical or mental weakness, "should be sent to school early to keep it out of mischief."

During the period of early childhood (from four to seven years of age) most of the knowledge gained by the brain is acquired chiefly, if not exclusively, through the organs of sight, of hearing, and of touch. The brain is thus kept in a state of healthy activity—receiving all manner of impressions, and storing up memories of what is consciously imparted to it. Of the special senses, sight is by far the most important to the child, because it is the most used.

Now, congenital and acquired *deformities of the eye* are not infrequent. They are among the most common of malformations—although too often unrecognized. Very often a serious defect of vision in a child is not suspected by its parents.* Again, the fact is frequently dismissed, even when the existence of such a defect is known, with the remark that "glasses are a disfigurement to a child, and that any child is better off without them than with them." I have been pained

them to an article contributed by myself to "Harper's Monthly Magazine," April, 1885, and to the popular work of Luys upon the "Human Brain," D. Appleton & Co.

* Far-sighted subjects have remarkably acute vision in spite of the fact that the eyes are too shallow. They see entirely by the aid of *muscular effort*, and sooner or later suffer from the effects of "eye-strain" unless the proper glasses are worn.

many times to hear medical men of intelligence support such a statement, and to urge their patients to avoid glasses as long as possible, in order that they might not become dependent upon them. To those who hold that idea, I would simply say that if they will read the article written by Dr. Loring upon this subject ("Harper's Monthly," August, 1879), and one by myself on a somewhat similar field ("New York Medical Journal," February, 1886), they will be convinced of their error and the sad results that may occur from such ignorance.

I earnestly advise, therefore, every parent to consult some expert (not an optician), before sending a child to school, and thus to ascertain if the organs of sight be anatomically perfect. If they are not so, the health and mental vigor of the child are liable to be slowly undermined.

I have seen serious damage done both to the health and mind of a child by the neglect on the part of parents to remedy an optical defect early by glasses. Many evil results may arise from the neglect of this simple precaution. Children very often become cross-eyed—the laughing-stock of their playmates—in consequence of an optical defect that has not been corrected early. Again, they frequently develop habits of idleness and incur the censure of their instructors on account of some optical defect, because their eyes cause them an indescribable sense of weariness when study is attempted, which a child is unable to withstand. I have encountered many adults who have struggled on to manhood with an ocular defect of which they were unconscious—suffering excruciating headache and many other symptoms of nervous derangement. When glasses brought relief at last, they have experienced an unknown sense of delight in reading and mental effort. I recall an instance of this character where a patient of mine would frequently rub a blistering lotion into the hair to relieve a headache that was almost incessant, and unfitted him for mental or physical labor. Glasses brought about a cure that was to him miraculous. The eyes of a child are fortunately more pliable and elastic, if we may use such an expression, than of an adult; hence some optical defects may be compensated for by muscular effort for years, although always with detriment to the physical vigor.

It is a difficult matter in many instances to make laymen, and even those of the medical profession who have given this matter little attention, appreciate the difference between "seeing without effort" and "seeing with eye-strain." The perfectly constructed eye should bring the images of all objects removed from it beyond the twenty-foot limit to a focus exactly upon the retina *without any effort on its own part.* It should be able to afford distinct vision of distant objects while passive; and thus rest itself from the fatigue of focusing objects within a circle of twenty feet radius. The far-sighted eye knows no such repose during the wakeful hours. Although the vision is very acute in most far-sighted children and in spite of the fact that

they are unconscious often of the strain produced by the unceasing muscular efforts required to see with distinctness, this condition of the eye tends (when not corrected by glasses) to weaken the nervous energies and produces in some cases the most distressing nervous symptoms. The far-sighted eye is particularly liable to be left without correction because its existence is often unsuspected.

2. I would suggest that the parents or guardian of a child, that has hereditary predisposition to debility or disease, should consult some intelligent physician respecting the advisability of sending such a child to school. Advice can then be had in regard to the studies which the child should pursue, and the daily amount of mental effort which it may safely attempt.

Some children are better able to apply themselves to study at five years of age than others are at ten. Irrespective of the fact that some of the brightest men of all epochs have shown remarkable precocity at a very early age and have been subjected to mental discipline when very young, I deem it wise to caution parents against an experiment that may prove disastrous to the future welfare of their offspring.

3. I would urge every parent, as a precautionary measure against disease of the brain, to avoid (from birth to the age of seven) all romps or other form of excitement immediately before the child is put to bed. Such excitement tends to prevent healthy sleep. It may thus precipitate the development of some nervous trouble in the child, by depriving the brain of its proper rest. Too much stress can not be laid upon this point. The error referred to is one that is thoughtlessly committed by thousands of parents.

4. Every child should get at least ten hours of good sleep each night. The old saying that "one hour's sleep before midnight is worth two after" is not to be disregarded. A child between the years of two and seven should be in bed and asleep by 6 P. M. every day.

5. The sleeping-rooms occupied by children should be large and well ventilated. They should be lighted by the direct rays of the sun, and have large windows. It is far better to give up the best room in the house, if necessary, in order to insure the health of your children, than to reserve it as a parlor for the entertainment of guests.

6. Children should eat at a separate table from their parents until ten years old at least. They should take their hearty meal at midday. It is not conducive to the proper development of any child to be surrounded constantly with food of which they should not partake; nor is it wise to load the stomach with food before retiring.

7. If you wish to keep children free from disease, avoid all pastries and sweets, as far as possible, and confine them to simple and nutritious food. The habit of feeding candy to children between meals, or of allowing them to eat at irregular intervals, is to be strongly condemned.

The nervous system is particularly affected by gastric and intesti-

nal derangements during childhood. This is also the case with adults, but to a smaller degree. Convulsions in children are often the direct result of improper feeding. I recall a case of an adult whom I once was called upon to treat, where an epileptic fit would invariably occur whenever he ate of banana. Stopping that fruit (of which he was very fond) cured the attacks.

8. Insure exercise for your children in the open air during all seasons of the year. Cold or inclement weather should not hurt a child if properly dressed for it. Avoid chilling the surface of the body or the contact of damp clothing to the skin, as far as possible, especially if the child has a hereditary predisposition to tuberculosis or scrofula. Even during infancy, I believe in the inhalation of fresh air for at least two hours daily, untainted by the gases of furnaces, gas-light, imperfect sewerage, etc., in which most city houses abound.

An open fire in the nursery tends to purify the air during the winter months, when the windows are kept closed; and prevents overheating of the room. The temperature of a nursery should never be allowed to exceed 70°, and should be as nearly uniform as it is possible to keep it.

Children with scrofulous tendencies or a hereditary predisposition to tuberculosis should be reared in the country, if possible, until they have passed the seventh year. This tends, in many cases, to prevent the development of hydrocephalus and epilepsy, to which such children are strongly predisposed.

9. Avoid in the case of children all books of a particularly exciting character.

This suggestion applies with great force to those who display a tendency to nervous affections, or who inherit a decided predisposition thereto. The paper-covered novels for boys, so extensively sold to-day, in which murder, rapine, and hair-breadth escapes are frequent, are very pernicious to the young.

Try and cultivate in your children a love for that which will both instruct and amuse them. Near-sighted children always prefer books and in-door amusements to out-of-door sports; hence they are usually spoken of by their parents and friends as precocious beyond their years. This is a mistake. Glasses will remedy the evil, and enable such children to enjoy romping games, etc., which imperfect vision had previously rendered impossible or unattractive.

10. Teach your children, even when young, to develop their memories. Do this by all possible methods, except the committal of prose or poetry in excess. Nothing pains me so much as to hear a very young child recite long pieces from memory, which could have been acquired only by protracted study. Such feats of memory may be followed by injurious results to the brain. It is said that a famous conjurer was accustomed to test his boy's perceptive memories by asking him to recall all he saw at a passing glance when walking by shop-

windows. In this way the boy was soon able to grasp, by his organs of sight, many details of objects that had previously escaped him.

The eyes are our most valuable organs. They afford food for thought, and give us one half of our information at least directly. If they are anatomically perfect, they can be used to perceive objects at a distance of more than twenty feet as perfectly as within that radius. Near-sighted persons can not do this, because objects of moderate size have to be brought closer to the eyes than twenty feet before their details are apparent. In many of our modern school-rooms the blackboard is more than that distance from the farthest row of seats; hence a near-sighted child can not see blackboard explanations well, and a far-sighted child is subjected often to an excessive and unnatural strain of the eyes in its attempts to follow them. Such exercises form a prominent feature in our present methods of teaching. It is an easy matter to teach children to dexterously use their eyes, as well as their ears and fingers, and to remember the details of all they see, hear, and handle, if the parents or instructors will use a little tact in that direction.

11. Encourage athletics in children, even at the expense of some mental progress, until the body is well developed. Healthy bodies tend to keep the mind vigorous and to prevent nervous derangements. Habits of exercise acquired during childhood tend to promote a love for athletics in the adult, which often helps to counteract the bad effects of anxiety and mental fatigue. Horseback-riding, hunting, fishing, base-ball, tennis, and other out-of-door sports, are important aids to longevity.

12. Respecting the education of children, I believe that object-teaching should be first employed, and continued until the child exhibits all the evidences of physical and mental vigor. It is time enough to begin systematic instruction when the brain is well stocked with memories of all kinds, and when the perceptive faculties have been made acute by careful discipline. Many a child has taught itself to read by playing with blocks upon which animals and other objects are printed above the letters that spell their names.

When the study of books is deemed advisable, let it be done in a well-lighted and thoroughly aired school-room, and not at home in the evening by artificial light. When the body is fatigued by play and the routine of the school during the day, it is contrary to common sense to weary the brain still more by urging a child to mental effort when the light is poor and the body needs rest. If a child must study at home, let it be done in the early morning hours, after a light repast on rising from the bed.

To my mind, the natural talents of each child should be allowed free scope for development. It is absolute folly to dwarf the brighter parts of a young intellect by a fruitless endeavor on the part of the parents or teacher to bring out some talent for which the child has

little or no aptitude. All minds can not be compressed into an identical mold without doing serious injury to some individual brains. A child with keen perceptive faculties and good reasoning powers is capable of growth in some directions, much more rapidly and with far greater pleasure to itself than in others.

Finally, I would suggest that parents study with care and anxiety the mental and physical traits of their offspring. Allow neither to detract from the other. Pick out for each child the line of development for which Nature seems to have furnished the best material, and the result will conduce to the future success of the child and the ultimate happiness of the parents.

RUSTLESS IRON.

By JAMES S. C. WELLS, Ph. D.

OF the many methods in use for the protection of iron from rust, the one of most scientific interest is the so-called Bower-Barff process. By this treatment the iron is coated with a layer of the black or magnetic oxide of iron (Fe_3O_4), and, as is well known, this oxide does not undergo any further oxidation on exposure to air or water—proved by the magnetic iron-ores and sands, which withstand any amount of weathering. The liability of iron to rust is a great drawback to its use for many purposes, and the practical value of a process which will protect it, at a slight expense, is self-evident. That the process is successful in accomplishing this object seems no longer a matter of doubt, and at less cost than galvanizing or tinning. The color on cast and wrought iron is a bluish-gray, which to some may be objectionable, but, as the coating takes paint far better than untreated iron, this objection is easily overcome, and with the assurance that the paint will remain, and not soon be thrown off as it is generally. For polished work the color is a lustrous blue-black, adding greatly to the beauty of the article treated. This process seems peculiarly well adapted for gas and water pipes. Any one who has had occasion to use water which has passed through a new iron pipe, or one that has not been used for some time, knows how full of rust it is, and that only after months of constant use does it become clear again. With pipe coated with the magnetic oxide by the Bower-Barff process, no trouble of the kind can occur. The water runs pure from the first day, and if for any reason the pipes are emptied, and left so, there is no danger of their becoming coated with rust. Another important fact is, that the water coming through one of these rustless pipes is just as pure as when it entered, for the water can dissolve none of the coating of oxide, as it always does with lead or galvanized pipes. It is a well-known fact that water running through lead pipes is very apt to

contain lead in solution, and the continued use of such water causes lead-poisoning, for, although the amount (of lead) dissolved may be very small, still it accumulates in the system, and finally causes sickness and disease.

Professor Venable has lately shown that water passed through galvanized pipe dissolves quite an appreciable quantity of the zinc coating, thus making it unfit for drinking purposes. Tin-lined pipes are also used, and until the introduction of the "rustless" pipe were considered the best, but were far from being all that could be desired; in many instances, after using for a time, the coating was completely destroyed. Then, again, if the pipe is to be better than lead, the tin used for the lining must be pure, because if it contains lead, which is often mixed with tin, it would be worse than the common lead pipe, the alloy dissolving much more readily than either would alone. Considerable architectural iron-work protected by the rustless process is being used with very satisfactory results. It is needless to multiply examples of its usefulness, for numberless ones will occur to the reader. Up to the present time only four furnaces have been built in this country—two in Brooklyn, one at Little Ferry, New Jersey, and one in Philadelphia. The processes by which this coating of magnetic oxide is formed differ accordingly as the iron is cast, wrought, or polished. The Bower process is the better for cast-iron, and consists in oxidizing it by means of carbonic acid and air. In the Barff method, which is the one used for wrought-iron and polished work, the oxidation is produced by means of superheated steam. This method will also give a coating of the magnetic oxide on cast-iron, but the action is very much slower than with the Bower treatment, and consequently more costly. The difference is probably due to the large amount of carbon contained in cast-iron, and which has to be oxidized as well as the iron, i. e., the carbon contained in the film of iron which is changed to oxide. It may be asked then, why, if air does the work so much quicker than steam, it can not be used for wrought-iron and polished work, as well as for cast-iron? It has been found by experience that the coating produced on the former, when air is used, is liable to scale off, which is not the case when it is treated with steam. Cast-iron after treatment seems tougher than before. I have frequently noticed, when present at the unloading of a charge of hollow-ware that had been treated, a kettle or pot fall off, and, although falling against heavy iron, it would bound off and reach the floor uninjured. The same accident happening to any such article before treatment is almost sure to break it. Whether this toughening is caused by a kind of annealing due to the slow cooling of the charge after coming out of the furnace, or whether it is that the surface of the iron becomes malleable owing to the oxidation of its contained carbon, I can not say, but think it probable that both contribute to the result. Mr. Bower, in his first experiments, treated the articles in a muffle-furnace—that is, a furnace

in which only the oxidizing gas, either air or carbonic acid, was allowed to come in contact with the iron; but this was found to be costly as well as unnecessary. Now the furnaces are built so that the products of combustion of the coal, used to heat the furnace, come directly in contact with the iron undergoing treatment, and by a suitable arrangement of dampers, etc., the same furnace can be used for the Barff or steam process. In his experiments the inventor found that, if he admitted a large excess of air, the article came out covered with the red oxide of iron (Fe_2O_3), and that below this red coating was a thin film of the magnetic oxide. For some time he was at a loss how to regulate the quantity of air added, so as to prevent the formation of this red oxide, but finally hit upon the following plan: During a certain time the iron was oxidized in excess, that is, to sesquioxide (Fe_2O_3), and then it was subjected to a reducing action for a definite shorter period. In this way it was obtained covered with the magnetic oxide only. The chemical reactions that take place are given by Mr. Bower as follows: the excess of air during the first part of the reaction causes the formation of sesquioxide of iron (Fe_2O_3),

$$2\,Fe + O_3 = Fe_2O_3;$$

but, this being in contact with red-hot iron, its lower surface is reduced to magnetic oxide, as shown in the following reaction:

$$4\,Fe_2O_3 + Fe = 3\,Fe_3O_4.$$

It would seem from this reaction that no reduction period would be necessary: theoretically it would not, but practically it is required, as there is always an excess of the red oxide (Fe_2O_3).

This excess of the red oxide is then reduced to magnetic oxide by the reducing gases, consisting chiefly of carbonic oxide (CO), which is converted into carbonic acid as follows:

$$3\,Fe_2O_3 + CO = 2\,Fe_3O_4 + CO_2.$$

When steam is used instead of air, the steam coming in contact with red-hot iron is decomposed, giving up its oxygen to the iron, and forming the black oxide, its hydrogen being at the same time set free as gas. The following shows the reaction:

$$3\,Fe + 4\,H_2O = Fe_3O_4 + H_8.$$

We will now pass to a description of the different processes, as carried out on the large scale. The furnaces in use vary somewhat in construction, but the principle is the same in all. The iron to be treated is placed in a large fire-brick chamber, known as the oxidizing chamber, into which the gases from the producers pass after having been through a combustion-chamber. In the latter the gases can be mixed with air, and burned, when necessary, the amount of air being regulated as required. The producers are simply very deep fireplaces, the bed of coal being three to four feet deep, so arranged that only sufficient air is admitted to burn the coal partially; that is, instead of being converted into carbonic acid (CO_2), it is only allowed to take up one atom of oxygen, and thus forms carbonic oxide (CO). The latter,

either alone or mixed with hydrocarbons, formed by the decomposition of naphtha, used during the reduction periods, is the gas that passes into the combustion-chamber to be there mixed with air or not, according to the result desired to be produced.

The fuel used in this country is anthracite coal, with the addition, during the reduction periods, of a little naphtha or crude petroleum. A small stream of the oil is led into the top of one of the gas-producers, where it is vaporized, and passes along with the other gases on their way to the oxidizing chamber.

Cast-iron before it can be treated requires to be "pickled," to remove any sand adhering to the casting. The "pickling" is done as follows: The iron is first placed in a bath of dilute sulphuric acid, and allowed to remain there for from ten to fifteen minutes, or even longer, if the casting is a very rough one. It is then removed and washed with boiling water, and when dry the sand which is now loosened is taken off with steel brushes. Now the article is ready for treatment in the furnace. The pieces to be treated are placed on the drag, a heavy iron plate, which is run into the furnace through a large door in one end. Before making the charge, the furnace must be heated to a white heat; having attained this temperature, the door is opened and the charge run in as quickly as possible, then closed and tightly luted, so as to exclude all air. The charge is heated with a slightly reducing flame, that is, one in which there is an excess of carbon, until it has reached a bright cherry red. During this heating of the charge only enough air is admitted to the combustion-chamber to partially burn the gases. When it has reached the proper temperature, the "gas" is turned on, that is, the supply of air is entirely cut off, a small stream of oil is allowed to flow into the producer, and the chimney-damper nearly closed. The flame in the furnace now becomes smoky. During this reduction or "gas" period, which usually lasts twenty minutes, the gases rich in carbon come in contact with the red-hot charge, and reduce any sesquioxide to magnetic oxide. At the end of this time the oil is shut off, the gas partially so, and the chimney-damper opened. When the furnace has become free from smoke, the air-valve is opened so as to let air enter the combustion-chamber in quantity only slightly in excess of that needed to burn the gases completely. This excess (of air), in conjunction probably with the carbonic acid formed by the combustion of the gases, oxidizes the iron to sesquioxide, which will be reduced by the next "gas" to magnetic oxide. When the oxidizing period, which lasts forty minutes, is over, the air-valve is closed, the gas turned full on, and the oil run into the producer as before, and the second "gas" or reduction period of twenty minutes begins. These alternate periods of reduction and oxidation are continued for from eight to ten hours, and the charge is drawn at the end of the last "gas," or, what seems to assure better results is, instead of withdrawing the charge now, to complete the treatment by admitting steam for

one hour, as in the Barff process, to be presently described. By thus finishing the operation with steam a more uniform color is obtained, due probably to the oxidation of any protoxide of iron that might possibly have been produced during the last reduction, thus insuring a coating consisting only of magnetic oxide. Wrought-iron or steel, of course, requires no "pickling," as there is no sand to be removed. The furnace is heated to the same temperature as for cast-iron, and then the charge is run in and heated up with a strongly reducing flame until it reaches a bright red. The "gas" is then turned on for twenty minutes, and, when this time has expired, the chimney-damper and gas-valve are both closed tightly, and the steam-valve is opened into the combustion-chamber. The steam, in passing through this chamber, which is at a white heat, becomes highly superheated before reaching the charge in the oxidizing chamber. It is known that sufficient steam is being admitted, by the amount condensed on a cold iron bar held at one of the openings, through which the excess of steam and the hydrogen set free in the reaction escape from the furnace. The steam is kept on for from eight to ten hours, and then the charge is withdrawn. When polished work is to be treated, the furnace is not heated so highly as for wrought-iron, and, just as soon as the charge has been made, the gas is turned on for one hour, then steam is admitted, and the operation goes on the same as for the latter, with this difference, that the temperature in the furnace is kept very low—so low, in fact, that on looking into the furnace the charge is scarcely visible. If too high a heat is used, it causes the coating to scale. The steam is kept on for from eight to ten hours, and the charge is taken out. At first the articles treated are completely covered with soot when they come out, and do not look attractive, but, on rubbing with oil, which is the next step, the soot is removed, and leaves the articles a beautiful, lustrous blue-black.

THE DEVELOPMENT OF MINERALS.

By M. J. THOULET,
OF THE SCIENTIFIC FACULTY OF NANCY.

IN a lecture on "The Life of Minerals," which was published about a year ago, I tried to bring out a few principles which seem to assert themselves as each day's work contributes new facts and suggests new thoughts in science, and which seem to give a general direction to the labors of investigators. These principles were, in brief, that all the laws relating to the mineral kingdom are also applicable to the vegetable kingdom, which is, besides, governed by other laws special to it; all the laws of the vegetable kingdom are valid in the animal kingdom, and it has, besides, its own other special laws. One of the results of the progress of science has been gradually to

make less distinct the lines that separate the three kingdoms from one another, so that we are led to the conclusion that the mineral kingdom is connected by successive degrees with the vegetable and animal kingdoms, and consequently that matter is one.

Hence the study of mineralogy, giving the word its real signification of a science applying to all unorganized bodies, ought to precede the study of botany and zoölogy, because it is the rational introduction to knowledge respecting the phenomena of Nature. There is manifest in these days an evolution from the sciences called natural toward the physical and chemical sciences, and from the physical and chemical sciences toward the mathematical sciences.

A natural phenomenon is the resultant of multiple actions which make themselves perceived concurrently in its manifestation. It is an equation containing many unknown quantities. There is only one way to resolve it: it is to find a sufficient number of other equations containing the same unknown quantities with different coefficients and exponents, and then to eliminate the unknown elements one after the other. That is the object of experiments, in which man intervenes with his intelligence and his hands to simplify and finally to resolve the problem that he proposes to himself, which is to obtain a complete knowledge of the phenomenon. In every experiment he retains as constants some conditions which he can not wholly get rid of, and limits himself to putting a single variable through its changes. He then makes constant the variable, of which he has just examined the influence, and subjects to modifications one of the other variables which he had previously held as a constant. This work is really the same as to formulate a new equation between different unknown quantities. Every science must therefore rest upon experiment, which alone is capable of leading to the knowledge of the law—that is, to a generalization, and of permitting the student to foresee results. A science which can not generalize or foresee only deserves the name of simple knowledge. Detailed observation translated into minute description is the servant of experimentation, for its task is limited to verification.

The science of inorganic bodies, mineralogy and geology, has been the first to feel the effects of the evolution of the natural sciences toward the exact physical and chemical sciences. Its phenomena present the minimum of complication; it ought, even more than the others, if that is possible, to be founded on experiment, measure, figures, and number.

I have been gratified to find my views on these subjects corroborated by the observations of Professor Mario Pilo, of the Lyceo Balbo in Turin, as recorded in a paper published by him in the "Rivista di filosofia scientifica," on "The Life of Crystals; or, Outlines for a Future Mineral Biology." This author has collected a large number of results agreeing with the doctrine of the successive and insensible

passage from the stone to the animal; and, although I am not in absolute accord with him in all his conclusions, we agree in the most essential points.

These studies are not of yesterday, and, as is the case with many other branches of knowledge, it is hard to go back to the first person who entered upon them. No branch of science is born in a day; but they all come to their growth in the minds of men and of masses of men by a kind of infiltration, or slow and often unconscious accretion. In 1867 M. Bombicci, Professor of Mineralogy in the University of Bologna, became especially interested in phenomena relating to minerals. Some of his experiments in crystallography were of particular interest, and were marked with the stamp of a rare originality of conception. But he treated the problems they suggested with great boldness, and carried his speculations upon them, perhaps, beyond the limits of rigorous science. It fell to M. Pilo's lot not to institute new experiments, but to collect those of M. Bombicci, his master and friend, correct and edit them, prune them of what about them was too technical, and, checking them with new facts duly substantiated, to present them in a more modest aspect, better deserving to attract attention. M. Pilo has given, in a kind of list, the analogies between the organic and inorganic kingdoms, and has concluded from them that there exists a kind of mineral biology. His memoir, aside from its philosophical parts, is a comparative chart of organic biology and mineral biology, and shows that all the branches of studies relating to organic beings can also be applied to minerals.

He begins by defining life as the state of integration of matter when it, departing from the simply molecular condition, arrives at the state of forming complex groups of determined chemical and physical structure, and becomes capable of reacting upon the ambient medium in such a way as to assimilate to itself the elements peculiarly suitable to it. The individual being a determinate chemical compound under a determinate form, the elementary crystal presents all the characteristics of individuality, comprising of them, under the name of crystal, all that has been called, with certain differences of significance, the integrant molecule by Haüy, the physical molecule by Delafosse, or the elementary crystalline stitch of the crystalline network by Bravais. I do not think that, even admitting this definition, we have any right to deny individuality to bodies that are called amorphous. It is not becoming to adopt the exclusiveness of the old mineralogy, which assumed to occupy itself only with the minerals existing in the bosom of the earth, and regarded as of its domain salt when it was found in mines, but refused to study the chloride of sodium which was produced in a laboratory. Amorphousness is still only a condition of form, and it would be absurd to give individuality to a gramme of crystallized sulphur, and refuse it when the same gramme of sulphur, having been fused, has been cooled in a vessel of water. The word

amorphous simply means not crystallized. Furthermore, the crystalline condition is connected with the amorphous condition by an uninterrupted series of gradations, as has been proved by the labors of Vogelsang and Lehmann. The former of these observers dissolved sulphur in sulphuret of carbon, and thickened it by mixing with it Canada balsam, the viscosity of which caused a delay in the crystallization at the will of the experimenter. By this method he substantiated a grouping of the matter into globulites, or minute isolated spheres; then into margarites, or files of spheres joined to one another. He next produced trichites, which are abundant in the obsidians—a kind of extremely fine threads of mineral, containing an internal channel, and rolling up in the most irregular fashion; microliths, under the various forms of longulites or belonites; and, finally, the crystallites and crystalline skeletons of Lehmann; and these, in their turn, led to real crystals. Each of these states presents itself as a more perfected condition than the one that precedes it, as a new appearance and complication of physical properties. Why, then, abruptly break the chain, and, having recognized the passage from the animal to the plant, and from the plant to the crystal, deny the transition, otherwise very visible, from the crystal to the amorphous body, and pretend that this is only a cadaver? Bodies sometimes crystallize under remarkably slight influences; under prolonged vibrations, as in the wire of suspension-bridges; depressions of temperature, like tin; or a simple molecular action, as do arsenious acid and barley-sugar. Glasses, according to the most general opinion, are constituted of an infinite number of interlaced crystals too minute to be distinguished by our microscopes, but which may be forced to arrange themselves in groups, and thus appear visible, by means of a prolonged roasting. In science we must be on our guard against absolutely affirming what our senses do not perceive, but we must be equally wary of supposing that things possess the same limits as the instruments which we are using to-day, but which the ingenuity of an inventor may bring to a greater perfection to-morrow.

In any case, especially if we restrict individuality to the definite chemical compound, the species is more clear in mineralogy than in biology, because it is more simple. The study of the structure of minerals is comparative inorganic anatomy, and, when crystallographers measure angles, refer the infinite variety of different solids to regular geometrical types, and class them in one or another of the six categories of crystalline systems, they perform the work of anatomists. To cite their names would be to write the history of mineralogy over again. We should have to begin with Erasmus, Bartholin, Huygens, and Stenor, and end with the immense number of those who are now engaged with crystallography.

The crystal does not, then, appear suddenly any more than the plant or the animal. It passes through an embryonic state, the general

study of which is embryology. And who knows whether the embryology of organic bodies, that science still wrapped in so much darkness, may not be illuminated with an unanticipated light when it shall be able to take for the basis of its investigations the results furnished by the embryology of inorganic bodies? MM. Monnier and Vogt have already imitated, by means of inorganic salts reacting upon one another, the forms of organic cells, and in a work, the summary of which was published in 1882 in the "Comptes Rendus" of the French Academy of Sciences, under the title of "The Artificial Production of the Forms of the Organic Elements," they have examined in detail these extremely delicate phenomena which carry us back toward the elementary origin of beings.

All beings are subject to certain general laws. Experiments in supersaturation show the action of continuity exercised by the parent upon the descendant which resembles it, and the conditions of existence, if not identical, are at least comparable for all. The crystal, in the solution into which it is plunged, increases by taking up, by means of a labor inherent to its nature, the particles which are suitable to it, and which become thus the food upon which it is supported. The struggle for existence is universal. Henri Sainte-Claire Deville announced the application of this thought to the mineral kingdom when, pointing to the iron tubes in his laboratory in which crystals were alternately heated and cooled, he remarked, sententiously, "The large crystals eat up the little ones." All bodies are subject to the action of ambient conditions. Among these incessant variations, these reciprocal influences of the medium upon the being and of the being upon the medium, are certain situations of greater stability, or positions of momentary equilibrium in which the body seems to persist, when an effort, a more considerable change, is needed to displace it. This equilibrium is not absolute. Susceptibility constantly exists, but it is manifested more or less clearly, so that we can define mineralogy as the study of the effects produced by different causes upon minerals. Sometimes a relaxation is apparent, a comparative retardation, a slumber, a lethargy, a catalepsy, a condition of real or apparent death. It is hard to express our idea by using such words as death or destruction, which possess a common acceptation that we are obliged, perforce, to stretch. "If we dry or deprive of heat certain inferior beings, frogs, aquatic insects, or some eggs," says Claus, in his "Zoölogy," "we can interrupt the vital functions for months and years, and still restore the life by returning the water and the heat. While there are some seeds that lose their germinating qualities after a few days, melon-seeds and beans are known to have grown after thirty or forty years, and even seeds of heliotrope and lucern that were found in the Gallo-Roman tombs, and were therefore fifteen or sixteen hundred years old, have been made to grow." The crystal, withdrawn from the mother-solution, and deprived of food, ceases to develop; it continues the same

in appearance, although its immobility is not absolute. If the air becomes moist, it falls into deliquescence; if too dry, into efflorescence. It does not possess the same volume nor the same angles in summer and in winter. Still, these changes are relatively slight, and if we take our crystal from the drawer, in which it has been kept inert, and put it in more favorable conditions, it will resume its development. Heated too much, attacked by a strong enough chemical agent, or subjected to any excessive influence, the body will be destroyed, and will experience the more profound modification commonly called death.

May we not also say that there are diseases of minerals? Can we not recognize in some of them a tendency to a healing, or, in other words, to a return toward the state of primitive equilibrium when the cause of the evil has disappeared—provided, always, that the divergence from that position of equilibrium has not been too considerable? We may cite in illustration of this hypothesis the numerous cases of mutilations of crystals that have been studied by Leblanc, Beudant, Lavalle, De Sénarmont, and M. Pasteur, on the bimalate of ammonia ground up in polishing, nitrate of lead, sea-salt, hydrochlorate of ammonia, or crystals of white potash alum, mutilated in certain lines, which, immersed anew in a solution colored with chrome alum, have their wounds cicatrized before resuming their interrupted development—a phenomenon which is made visible by the difference in color of the two isomorphous salts. These curved, twisted, deformed, and monstrous crystals, diverted from regularity by causes most usually unknown, but of which science is on the way toward discovery, would make, in regard to their malformations, objects of a mineral teratology.

The higher the stages of development which bodies reach, the more their forms become complicated; here, again, the chain seems to be uninterrupted. I thought I had substantiated a tendency toward perfection in the curious so-called mimetic appearances which plagiocase feldspar, leucite, analcime, senarmentite, and many other minerals exhibit, phenomena by which many crystals belonging to a more complicated system group themselves in a determined number, so as to offer the deceptive appearance of a single individual belonging to a less complicated system. M. Pilo, on the other hand, sees in this march toward a more simple form a retrogradation, an inverse phenomenon of degeneracy, which he compares to atavism. I yield to his view, and in doing this take notice of one other correlation between the two opposite extremities in the scale of beings. There is also a passage of crystalline systems among themselves, and each property effects this passage separately—a displacement of optical axes which, diminishing their angle, transforms a biaxial crystal to a uniaxial one, successively for each of the colors of the spectrum; an unequal thermic dilatation, positive or negative, following the three axes

of elasticity, null in some directions; variation in the mutual inclination of the facets; in the same system, a transition from hemihedral to holohedral forms by sharp grouping in some cases, by striæ like those of pyrites and quartz, of holohedral forms to forms hemitropal in different degrees, and to hemimorphal forms. The complication goes on increasing.

We will end by a last trait of analogy. Just as some animals and plants, when they are by any cause placed in a medium offering the largest sum of propitious conditions, attest the excellence of that medium by a more complete development of the individual and of the number of individuals; as there exists a zoölogical geography and a botanical geography, which distinguishes and enumerates for each species the most favored or most favorable regions—there exists also a mineralogical geography, which fixes the cantonment of particular minerals in certain countries. In the Island of Elba, more than anywhere else, is found oligist iron; in the Hartz and the Ural, ores, and native metals; in India, Brazil, and South Africa, gems and diamonds; in California and Australia, gold; in Canada and Chili, copper; in Siberia, malachite; and in Iceland, Iceland-spar. This study has been elaborated for some substances—tin, for example—in the admirable labors of Élie de Beaumont.

Thus, since we have for minerals an embryology, an anatomy, a nosology, a teratology, and a geography, a vast assemblage of facts many of which are known and more unknown, we may also conclude upon the existence of a mineral biology. When every one of the chapters which it embodies shall have been treated experimentally, we may come into a condition to formulate its laws. The artificial barriers raised by our ignorance between the different branches of knowledge will one after another be leveled. Natural history will become easy, like physics and chemistry, now that physics and chemistry, as Lagrange foresaw, have become easy; or, rather, all the sciences will be consolidated into one science, which will be one because matter, the object of its investigations, is one. Every time the mind of the investigator escapes beyond the work of detail which he daily performs in his laboratory, the contemplation of an ideal far removed, but which he is certain he or those who will follow him will attain, gives him new strength to go back to that daily labor, marks an advance, infinitely little but certain, toward that ideal. A glance over its history shows how mineralogy has grown. It seems as if it were conscious of the end toward which it is tending, of connecting the sciences called natural with the exact sciences. As M. Pilo has happily remarked, mineralogy has traversed the period of magic with the alchemists, the empiric period with the experimenters of the seventeenth century, the naturalist's period with Linnæus, Buffon, and Werner, the geometric period with Haüy, Delafosse, and Bravais, the chemical period with Berzelius, and the physical period with Fresnel,

Mitscherlich, and De Sénarmont. It is now time for it, gathering up the scattered results it has collected, and adding new conquests to them, to enter resolutely into the biological period.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF GERARD MERCATOR.

GERARD MERCATOR, the distinguished geographer and author of the system of map-drawing which bears his name, was born at Rupelmonde, Flanders, March 5, 1512, and died at Duisburg, December 2, 1594. The name by which he is known, Mercator, is a translation into Latin of his real name, which is given by one authority as Kaufmann, by others as Krämer, or De Cremer, all meaning merchant or trader. He was first sent to school at Bois-le-Duc, under Macropedius, but afterward went to Louvain, where he applied himself to the study of philosophy and mathematics so earnestly that he was prone to let his days pass without eating and his nights without sleeping, and had to be reminded that those duties should be attended to. Of the nature and influence of his studies at Louvain an interesting incident is related by his biographer, Van Raemdonck ("Gérard Mercator, sa Vie et ses Œuvres"), which also illustrates a striking trait of his character. The Bible to him was a book of authority, and he had conceived a high respect and formed a fixed attachment for its text. He had also been taught the physics of Aristotle, which then prevailed in all the schools. His studies in the book of Genesis soon showed him that there were many discrepancies between the cosmogony of Moses and the teachings of Aristotle and other accepted philosophers; thus a dilemma was presented to him. He would not give up his Bible; must he give up Aristotle? To relieve himself from his embarrassment, he took a course, says Van Raemdonck, "that was as Christian as it was logical. Believing in the inspiration of the Bible, and convinced of man's fallibility, he ventured to doubt the orthodoxy of the philosophers, resolved to revise all his accepted opinions, and, with his reason as his only guide, undertook to penetrate for himself the mysteries of Nature." He went to work to construct a new cosmogony. In order to escape critical annoyance, he left Louvain and retired to Antwerp, where he hired rooms and gave himself up to his investigations on this subject. There he framed a cosmogony which agreed at once with his reason and with the Bible. When he returned to Louvain, the doctors of the university, shocked at his boldness in questioning what was almost universally received, were ready to attack his new doctrines, anticipating their immediate publication. But he kept his own counsel, and held his cosmogony in

his portfolio till such time as he should judge best to make it known. Being obliged to make his living by manual labor, Mercator selected the making of mathematical instruments, with the designing, engraving, and illumination of maps, as his business. He thus entered upon a career which he never left, and which was destined to bring him fortune and glory. In order better to qualify himself for doing this work, he began a thorough course of mathematics. He studied with Gemma le Frison, who was in the habit of giving lessons at his house to a number of high-born pupils, and practiced engraving with him. He made rapid progress, and was able in a short time, having been licensed by the university, himself to give lessons in geography and astronomy; and he made with a precision which was remarkable at that time the instruments which his pupils had to use. In 1541 he presented to Cardinal de Granville a very handsomely executed terrestrial globe, with which his Grace was so well pleased that he introduced the author of it to the Emperor Charles V. He afterward entered the service of that prince, but it is not exactly known in what particular capacity. He is styled in his epitaph *imperatoris domesticus*, but that merely signified that he was attached to the imperial household. He made for his Majesty two other globes, a celestial one of glass, and a terrestrial globe of wood, which were greatly admired as superior to any specimens that had been before produced. They were unfortunately destroyed in the wars by which the Low Countries were afterward overrun. In 1559 he removed to Duisburg, where the Duke of Juliers and Cleves was contemplating the establishment of a university, and had assigned an honorable position in it to Mercator. The duke conferred upon him the appointment and title of his cosmographer. He published at that place a large number of maps, but delayed the publication of his atlas for a considerable time, out of regard to his friend Ortelius, who had also prepared a set of maps, and through Mercator's accommodating spirit was given an opportunity to work off his stock without the embarrassment of competition. It is to Mercator and Ortelius that the world owes the enfranchisement of geography from the errors ingrafted upon it by Ptolemy; and the maps of these two fellow-workers were the most exact known till those of Guillaume de l'Isle and D'Anville were published.

Geography was in his time a mixture of facts and fancies, much of what was taught in it having no better authority than old-time traditions and the fabulous stories of travelers who addressed themselves more to exciting wonder than to telling the truth. Maps were in a worse condition than the descriptive accounts, and gave the most erroneous possible views of the relative situation of the various parts of the earth. It was Mercator's work, to adapt an expression of Malte-Brun's, to demonstrate the extreme imperfection of the systems of the ancients and provoke their abolition. Modern geography, this distinguished

authority on the subject adds, dates from his time. He seems to have had a strong natural taste for the study of this science, to which he himself testified when he said, in the preface to his "Chronology": "I consecrate myself wholly to that study, so beautiful, so useful, and at the same time so difficult. Nothing in the world is so pleasant to me. In fact, compared with it, other occupations, no matter how necessary they may be, are irksome to me." In his opinion, a knowledge of geography was indispensable to successful government and lucrative commerce. "Without maps, giving visible representations of the whole of an empire and its different countries," he said, "merchants would not be able to reach the richest and most important lands, to trade there, and bring all the earth into fraternity with Europe; and, without them, princes could only with difficulty and by means of intermediaries, often of doubtful fidelity, arrive at safe and stable decisions respecting the government of their dominions." Thus, availing himself of the instructions he had received from Gemma le Frison, and having served no other apprenticeship in the art, he began, about 1537, to design on paper, and then to engrave on copper, and illuminate the chorography of various countries. "The skillful instrument-maker became also in a short time an accomplished map-engraver; and no maps of his time were comparable in workmanship with his."

Mercator's principal title to fame rests upon his invention of the method of drawing maps, which is known as Mercator's Projection. Under this system the map represents the earth as an unrolled cylinder, and the poles are remanded to infinity. The parallels of latitude and the meridians are drawn as straight lines, crossing one another at right angles. This method gives a tolerably fair representation, and accurate enough for practical purposes in the neighborhood of the equator and for about thirty degrees on either side of it; but, in approaching the poles, the proportions of the parts are distorted. The length of the degrees of longitude and of the parallels is exaggerated—vastly in the immediate neighborhood of the pole—for to preserve the parallelism of the meridians and their perpendicularity to the parallels of latitude, the degrees must be drawn of equal length in all parts of the map. The plan has, however, the great practical advantage for sailors of causing the curve drawn on the sphere crossing all the meridians at the same angle—the loxodromatic curve, which a vessel would describe in sailing around the earth without changing its course—to be projected into a straight line. It thus furnishes a way in which the bearing of a vessel sailing directly between two distant ports can be clearly discerned on the map. While Mercator was successful in executing the designs of his maps on this method, he was not able to explain its theory, or at least did not explain it. The explanation was given by Edward Wright, in 1599, in his "Correction of Errors in Navigation," and from this circumstance the method was long known to the English as Wright's Projection.

Mercator expressed a full appreciation of the importance of astronomy as connected with geography. That science was then cultivated largely in connection with astrology and was invoked in the solution of the most trivial questions. For this he had a profound contempt, while he believed in the significance of celestial phenomena and extolled the study of them. "The purposes for which the luminaries of the sky are created," he said, "are much higher than to assist in the predictions of the astrologers. Those lights exist to reveal to man the omnipotence, the majesty, and the divinity of his Creator, and not to be at the service of the vanity of the astrologers. They exist to mark the revolutions of the centuries; it is for this that they become obscured and are dissolved to announce the end of ages and proclaim judgment upon the world. It was thus that in the time of the passion of Christ, when the law was to be changed, Dionysius the Areopagite was permitted to see an eclipse. It was thus that Joshua perceived the astounding action of the hand of God in the spectacle of the sun. These bodies exist to mark the limits of days and years; and the stars, which glow by night in the firmament, shine upon the earth, and point out by their position the annual course of the sun." Mercator had collated the results of his studies on this subject, and had announced for publication a work embodying them, when death prevented his carrying out his intention.

Among the larger works mentioned by various authors as having been executed by Mercator, are the maps of Palestine, Flanders, Europe, Great Britain, Lorraine, the terrestrial and celestial globes already mentioned, and a great planisphere. These were all larger than the maps of the atlas. None of them, except the planisphere, are now known to be in existence. A few loose sheets from the plates of the atlas, preserved in collections at Brussels, London, the Hague, and St. Petersburg, constitute the chief part of the works of this class known to be by him that are now extant. For his chorography of Palestine —"Amplissima Terræ Sanctæ Descriptio" ("Most Ample Description of the Holy Land"), Mercator had to depend upon the best authorities he could command—"the testimony of an unknown traveler"—and they have not been identified. He is credited, however, with having made good use of the critical faculty in the composition of the work. It had the honor of having been sought for by the learned André Masius for the illustration of his commentary on the book of Joshua, who, in a letter to Georges Cassander, spoke of it in the most complimentary terms. The map of Flanders was produced after the spending of three years in personal surveys of the country, and appeared in 1540. It exists now only in reduced copies in the "Theatrum" of Ortelius and in Mercator's atlas; but the historian Jacques Marchantius, who had seen it, says that it surpassed all the maps of all other geographers. The map of Lorraine was also made after personal surveys, in the prosecution of which the author appears to have been exposed to

some danger. When the map of Europe appeared in 1554, with Ptolemy's errors corrected and the continent shown in something like its real extent and proportions, the learned of all countries, according to Ghymmius, pronounced such extravagant eulogies upon it that one might have thought that no such perfect work had ever before seen the light. A single copy of his great "Mappa Monde" exists in the Bibliothèque Impériale of Paris. It is two metres by one metre thirty-two centimetres, or about six feet and a half by four feet, in dimensions, and shows the world from 80° north to 66° 30′ south. It includes three continents or land-masses—the Old World, America, and a southern continent, which Mercator conceived to be necessary to the balancing of the globe, but which had not yet been found, and which is only imperfectly represented by Australia and the larger islands and the south polar lands. The regions around the pole could not be given, on account of the exaggeration of the degrees on the plane projection, so a special supplementary map was provided for them. As not much was known about these regions, not much could be shown, and the little that could be, with no great accuracy. Behring Strait had not yet assumed definite form in the minds of geographers, but Mercator, thinking there ought to be some such body in that region, marked one on the map. In the main map also, some curious features were marked in the islands of the ocean, on the word of travelers, that have not yet been verified.

The "Atlas" was published in 1595, although several of the maps had already been published separately, that of France in 1585, and the map of Europe in 1572. Larger and smaller forms of the work were published in Latin, French, German, Flemish, and Turkish, in at least fifty editions. The more important editions were published by Hondius, at Amsterdam. That of 1623 had one hundred and fifty-six maps, and the edition of 1630 was prefaced by a biography of Mercator, by Gautier Ghymm (Ghymmius). This work included accounts of the political and the physical geography of the countries described.

To the uniform edition of his maps, Mercator prefixed an essay, "De creatione ac fabrica mundi" ("Concerning the Creation and Structure of the World"), the theological doctrines of which excited some question. But Van Raemdonck, his admiring biographer, says of it: "We have hardly been able to disengage ourself from the reading of it, so much does it attach, lead on, and transport us. In turning over those noble and pious pages, we might have thought we were reading a sacred canticle, a real hymn to the Lord. Invocation of divinity, holiness of purpose, grandeur of conceptions and ideas, sublime style, and enthusiasm—all are there and help to make us believe, with Dr. Solenander, that Mercator speaks in this book as an inspired prophet, as one who has been initiated by God himself into the mystery of the origin of the world."

In preparing his maps, Mercator had to give attention to the study of the best methods of lettering. The results of these studies were published for the information of the public, in an essay on italic and cursive letters—"Ratio scribendarum literarum latinarum quas italicas cursoriasque vocant"—which was a treatise on calligraphy and much more; for it embodied the fruit of much thought and careful investigation on a subject which was of great importance, to him at least.

The services of Mercator were in frequent demand for the preparation of maps of private estates, and from this occupation he was able to meet the current expenses of his living and his family, and derived a considerable income.

Mercator's most important work, after his maps and atlases, was his chronology: "Chronologia a Mundi exordio ex eclipsibus et observationibus ac bibliis sacris" ("Chronology from the Beginning of the World; from Eclipses and Observations, and Holy Books"); Cologne, 1568; Basle, 1577. It was an elaborate work, the result of four years of labor, and gave 3965 years from the creation to the birth of Christ. Scaliger expressed a high opinion of it, and Lenglet Dufresnoy spoke of it as clear but dry; but it was pronounced by one of the best judges of the time, Onuphre Panvini, of Verona, author of several historical and chronological books, preferable to all existing chronologies. In the preface to this work he sketched a plan of a universal cosmography. Repeating this plan in 1585, he described it as intended to include, first, the form of the world and the general distribution of its parts; second, the order and motions of the heavenly bodies; third, their nature and radiation, and the concurrence of their influences, from which may be derived a veritable astrology; fourth, the elements; fifth, descriptions of kingdoms and of the whole earth; sixth, the genalogies of princes from the beginning of the world, with the emigrations of the peoples, their abodes, their first inventions, and antiquities. This order was not, however, observed in actual publication.

Piety was a predominant feature in all of Mercator's life. To extol the works of God, he said, "to exhibit the infinite divine wisdom and inexhaustible goodness by showing how all things in their composition concur to glorify him and reveal his incomprehensible providence—such is the end toward which I shall direct all my efforts, all my readings, and all my meditations."

This feeling it was, probably, that impelled him, in the latter part of his life, to give attention to theological questions, and which prompted the composition of his "Harmony of the Gospels" ("Harmonia Evangelistarum"), which was published at Duisburg in 1592.

He seems to have had opinions of his own on theological subjects, even earlier in his life—and that was against the order of society. He

was arrested in 1544, while residing at Louvain, by order of some one having authority in the prosecution of heretics, and imprisoned, on a charge of being infected with the Lutheran doctrines. Twenty-eight other citizens were taken under the same order, but Mercator, being at Rupelmonde to look after the estate that had been left him by his great-uncle, escaped till he was found. His absence from home was construed into a confession of guilt by flight. His parish priest immediately addressed a letter to the authorities, testifying that "Gérard Mercator enjoys a good reputation, lives a religious and honorable life at Louvain, and is in no way infected with heresy"; and that he was always to be found at home, except when absent on legitimate business. The conservator of the university demanded that he be tried, if he was to be tried, before the court of that institution, within whose jurisdiction he resided; and the rector of the university interceded in his behalf. But all these protests were without immediate effect. He was kept in custody for four months, and then discharged, in the absence of evidence against him—and, perhaps, by the force of the evidence for him.

Two works of Mercator's remain to be mentioned. They are his edition of Ptolemy's "Geography" ("Tabulæ Geographicæ ad mentem Ptolemæi restitutæ et emendatæ"), with twenty-seven maps; and his "De usu annuli astronomici" ("Concerning the Use of the Astronomical Ring"), an explanation of the horizon, meridian, and other rings of his globes.

Mercator is described as having been small, but well shaped. He regarded material life as a necessity and not as an enjoyment, and was strictly sober in his repasts. But the gravity of his labors did not exclude gayety; and, in whatever festivities, official or private, he participated, he contributed to the general good cheer with his sprightly humor, and yielded to the tastes of the others such conformity as was consistent with his health and the precepts of religion. He was vivacious and adroit in discussion, easy and agreeable in conversation, and knew no greater pleasure than to talk familiarly in the society of the learned concerning subjects of knowledge. Observing moderation in good fortune, resigned and patient in adversity, he constantly preserved the calm that was necessary and favorable to his studies. And he was distinguished for his devotion to the interests of his country.

CORRESPONDENCE.

"AN ECONOMIC STUDY OF MEXICO."

Messrs. Editors:

I HAVE read with interest the article under the above title published by Mr. David A. Wells in the April "Popular Science Monthly," and, while I admire in it the author's smoothness and facility of style, I can not afford, as a Mexican, to let it pass without at least pointing out some of its many inaccuracies in regard to history and current facts.

It does not require great acuteness of mind to perceive, *prima facie*, that, in preparing his article, Mr. Wells has been more careful to pick out the best way of showing his predisposition against Mexico, than to make an accurate representation of things as they really are, and as they have been narrated by more competent and judicious persons. I am far from affirming that all the assertions of Mr. Wells are equally deficient in justice and truth, but I do hold that in no instance do we see him disposed to point out our *good things* among the *countless bad ones* he so eagerly mentions.

If I were to review Mr. Wells's "Economic Study of Mexico," I should begin by saying that while he thinks that "the majority of those who in recent years have visited that country would seem to have brought to their eyes the power of seeing little else than the picturesque side of things," I believe that he has exerted his powers of vision to see nothing else than the gloomy side of them, for so it must appear to everybody conversant with our modern history who may peruse the "Economic Study of Mexico."

According to Mr. Wells's notions, Mexico is one of the most stupid, the most insecure, the poorest, the most arid, the most miserable countries of our planet, and all candid readers who may be pleased to read his thrilling descriptions might think that they are the product of long, careful study and extensive travels, and not of a rapid pleasure trip along the Mexican Central and National Railroads. But to the thoughtful and intelligent reader it will rather appear a ridiculous pretension to try to demolish, with such an imperfect and unqualified knowledge, all that thoroughly competent men have written in regard to the immense natural resources of this country. It may be admitted that Mexico, as a nation, is poor, but as a country it may be classed among the richest in the world, despite the efforts of Mr. Wells to establish the contrary. Has Mr. Wells ever read the writings of Humboldt, Burckhardt, Egloffstein, and many others, about the wonderful natural richness of this country? Has he ever consulted the official statistics and reports? I think not, or else he enforces with his example the truth of that old saying that "the most blind is the one who does not want to see"; or perhaps Mr. Wells, considering himself the *ne plus ultra* in matters of authority, will emphatically assert that the writings of those great men are mere stories, destitute of all value, or, as he says of the historic writings of Mr. Prescott, are nothing more than "charming romances." It is very easy to dispose of authorities in this peculiar way of Mr. Wells, but the real damage inflicted by so doing is scarcely greater than that which would result if I were to try to stop the course of the sun with my hand.

It is very striking to see Mr. Wells completely disregarding our natural resources, especially our mines. In a period of one hundred and ten years (1690–1800) of the colonial epoch the mines of Mexico produced, in gold and silver, the sum of $1,499,435,898.* The pure mines of Guanajuato produced in a period of forty years (1766–1808) the respectable amount of $165,002,145;† and the Valenciana mine alone yielded from 1766 to 1826, in round numbers, the sum of $226,000,000.‡ Next in importance is the Zacatecas district, which, according to respectable authorities, produced, from 1548 to 1883, the astonishing sum of $1,000,000,000.§ But it would be an endless task to pursue our investigations about the many other mining districts of our country which also have yielded immense quantities of silver and gold; and what we have said of Guanajuato and Zacatecas surely will be sufficient to give an idea of the importance of our mines.

Our agriculture, it is true, has not been rightly developed, partly on account of the many revolutions we have had in past years, and partly on account of the fact that our attention is chiefly directed to the mining industries; yet we produce enough wheat, maize, beans, coffee, sugar, etc., for our consumption, and have a regular surplus for exportation. But even if we did not produce a single grain, on account of the imperfect development of our agriculture, the argument would be a very poor one to brandish against the fact that our soil is rich and exuberant.

On account of the same revolutionary state of the country from the epoch of in-

* Humboldt, "Political Essay on New Spain," vol. ii, p. 91.
† Ibid.
‡ Dahlgren, "Historic Mines of Mexico," p. 88.
§ Ibid.

dependence till eight years ago, our highways have been somewhat insecure, especially those more distant from centers of population, but never to the extent asserted by Mr. Wells; and at present I am sure that, in this respect, we are no worse than the United States or any other of the nations called civilized.

It has been always the practice of Americans to despise and abuse Mexicans (of course there are many honorable exceptions to the rule) whenever it was possible to do so, as I had occasion to notice during nearly two years that I lived in San Francisco, California. This, I believe, is a mere question of race, but it none the less awakens a feeling of antagonism, at least among the uneducated classes of Mexicans. The ex-minister to Mexico, Mr. John W. Foster, was not an exception to the rule of what I have said, when he wrote to the merchants of Chicago the exaggerated report to which Mr. Wells alludes. When that memorable piece of Mr. Foster's literary ability was published in the journals of Chicago, ex-deputy Martínez Negrete, of this country, had just arrived in that city, on his return from the Exhibition at Paris in 1878. As soon as he read the unfair communication of Mr. Foster, he made a very patriotic and energetic reply, and published it in one of the evening journals of that city, waiting there for results several days. The fact that there was never an argument adduced against our deputy's article, proved conclusively the lack of truth in Mr. Foster's malicious report. Señor Martínez Negrete, in showing at that time that there were robberies in the United States as well as in Mexico or other countries, among other things pointed out the recent and scandalous fact of the stealing of A. T. Stewart's corpse from the tomb, an event the parallel of which never has occurred in Mexico.

Now let us hear Mr. Wells discourse about the ancient civilization of Mexico: "The general idea is, that the people whom the Spaniards found in Mexico had attained to a degree of civilization that raised them far above the level of the average Indians of North America, more especially in all that pertained to government, architecture, agriculture, manufactures, and the useful arts, and the production and accumulation of property. For all this there is certainly but very little foundation, and the fascinating narrations of Prescott, which have done so much to make what is popularly considered 'Mexican history,' as well as the Spanish chronicles from which Prescott drew his so-called historic data, are, in the opinion of the writer, and with the exception of the military records of the Spaniards, little other than the merest romance, not much more worthy, in fact, of respect and credence, than the equally fascinating stories of 'Sindbad the Sailor.'" Who could refrain from laughing at such a pompous and presumptuous way of dealing with historic matters? Perhaps Mr. Wells blames Mr. Prescott for not having drawn the materials for the "History of the Conquest of Mexico" from the annals of China or Japan. . . . But the most curious thing about Mr. Wells is the boldness with which he rejects the Spanish chronicles and the writings of Prescott without offering any better authority to upset them; he may be a man of unlimited knowledge, but we refuse to adopt him as the standard authority in the "History of Mexico," for which refusal, I am sure, the sensible world will justify us. If Mr. Wells has not learned anything about the advanced civilization of the ancient empires and kingdoms of Mexico, we advise him to read the famous historic writings of Clavijero, Las Casas, Alamán, Orozcoy Berra, and others, and the no less important archæological and philological works of Chavero and Pimentel. There he will find ample evidence of the Indian civilization which he denies now without proof. The facts narrated by the writers cited have been widely illustrated and proved by the majestic and highly interesting ruins of Uxmal, Mitla, Magdalena, and several other places, in the States of Yucatan, Oaxaca, Pueblo, and Sonora, which have attracted so much attention and study from national and foreign archæologists.

From all that I have said it is clearly seen that Mr. Wells has been very hasty and unscrupulous in his article with which he tried to take the public by surprise; but I can assure the readers of the "Monthly" that, if there is any *economy* in Mr. Wells's "Economic Study of Mexico," it is to be found in the amount of truth comprised in the narrations which it contains.

P. F. Mange.

Alámos, Sonora, Mexico, *May* 5, 1886.

EDITOR'S TABLE.

SCIENCE AND THE STATE.

IN this country we have no state Church; but, on the principle perhaps which, whether scientifically true or not, seems often to be illustrated in human affairs, that Nature abhors a vacuum, we have in its stead a very notable development of state science. In other words, our Government no longer assumes to point out to us the

best methods for promoting our spiritual welfare; but it kindly, and in a most paternal spirit, undertakes to show us the true path of intellectual and economic salvation. Formerly it was religion that could not thrive without state support; now it is science. Formerly it was the priest who undertook the solution of all difficult questions and who stood forth as the visible embodiment of authority; to-day it is the director of an official scientific bureau. In former days it was said that all roads led to Rome; to-day in the United States we are rapidly approaching a state of things under which all the paths of science at least will lead to Washington. There it is that a generous Congress—generous with the people's money—votes rich appropriations for work, the nature and scope of which not one member in twenty understands. There it is that the authority resides that can hire scientific labor in every part of the country, and provide a profitable market for all researches, observations, and theories that fall into line with the main doctrines of official science.

When evils reach a certain height they are apt to attract an attention and awaken a resistance that were lacking in their earlier and less threatening stages. A bill, a copy of which is before us, reported by the "Joint Commission on the Coast and Geodetic, the Geological and Hydrographic Surveys and Signal Service," seems to indicate that, as regards the Geological Survey, the point of danger is recognized to have been reached. It bears as its title, "A Bill restricting the Work and Publications of the Geological Survey and for other Purposes." The proposition is to confine the survey for the future to strictly geological work, such as may be necessary for the preparation of a good geological map of the country. According to the terms of the bill, it is not in future to expend any money for paleontological work, "except for the collection, classification, and proper care of fossils and other material." It is not to undertake the general discussion of geological theories, "nor shall it compose, compile, or prepare for publication monographs or bulletins, or other books except an annual report, which shall embrace only the transactions of the bureau for the year and the results thereof." It is further provided that in future "all printing and engraving done for the Geological Survey, the Coast and Geodetic Survey, the Hydrographic Office of the Navy Department, and the Signal Service, shall be estimated for separately and appropriated in detail for each of said bureaus."

Such in substance is the bill. In support of its provisions the chairman of the commission, Mr. H. C. Herbert, gives a summary view of the present extent and variety of the work undertaken by the Geological Survey and of its cost to the country. Taking the latter point first, he shows that, leaving the cost of publications out of the question, the present annual expenditure on the survey amounts to something over half a million dollars, or eighty thousand dollars more than is expended by Great Britain, France, Austria, Switzerland, Italy, Sweden, Russia, Belgium, Norway, Bavaria, Würtemberg, Finland, Canada, Victoria, and Japan taken together. These other countries understand by a Geological Survey, a survey undertaken for the purpose of establishing the main geological features of the national territory; and for this purpose they severally find a moderate expenditure sufficient. In this country a different theory has apparently prevailed. Here a Geological Survey is a bureau invested with authority, and provided with funds, to undertake not only the widest possible investigations of a geological kind, but also minute researches in paleontology, paleobotany, and lithology, together with the study of a variety of economic questions touching on the processes of metallurgy and the general

use of minerals. The director of the survey states that there are in the survey three distinct corps of geologists engaged in the study of economic geology; that there are five distinct paleontologic laboratories; that there are three other laboratories—one chemical, one lithologic, and one physical; that there is an extensive geological library, the librarian having a corps of assistants engaged in bibliography; and that, finally, there is a division of mineral statistics, with a large corps of men engaged in statistical work, the results of which are published in an annual report entitled "Mineral Resources." The annual expenses of publication in connection with the survey are estimated to exceed two hundred thousand dollars. This, however, is exclusive of any expenditure on the geological map of the country, supposed to have been for some years in preparation, but of which no portion has yet been published. The minimum cost of this map is put at $1,690,000 *for plates alone.*

Now, to any reflecting mind it will be quite apparent that the Government can not undertake all this varied scientific work without discouraging the application of private effort and study to the same field. "There is no more reason," says Professor Agassiz, in a letter to Mr. Herbert, "why the Government should publish a history of the mining enterprises of the country than that they should publish a history of manufacturing processes." So with paleontology. "This," according to Professor Agassiz, "is just one of the things which private individuals and learned societies can do just as well as Government." Much of the matter, he further observes, which is published in official bulletins would be published by private individuals or societies if the Government did not lay hold of it; while, on the other hand, much of the stuff which the Government prints would *not* be printed by private individuals or societies *even if they had the necessary funds at their command.* The main result of Government interference would thus appear to be the unnecessary official publication of a certain amount of good matter and the wasteful publication of a quantity of comparatively, if not absolutely, useless matter. Professor Agassiz furnishes to Mr. Herbert a list of forty-eight publications of the Museum of Comparative Zoölogy at Cambridge, and most significantly states that he had "a written proposition from a former Superintendent of the Coast Survey, offering to publish all this as appendices of the Coast Survey reports at Government expense"—an offer which he "respectfully declined to accept."

To show the value placed, in the markets of the world, upon the publications of the Geological Survey, Mr. Herbert calls attention to the fact that, though the law of its organization requires the survey to sell its publications, not exchanged, at cost, and turn the proceeds into the Treasury, the whole amount thus realized in six years was $1,543.10—testifying to an annual demand to the amount of $257.18.

We have thus far referred only to the Geological Survey; but the report before us gives a statement of the total cost of the several surveys organized by the Federal Government, exclusive of the cost of printing. The amount is close upon a million and a half of dollars. That no *adequate* return is being received from this really vast expenditure there is too good reason to believe; but that is not the worst feature of the case. The worst feature is that hinted at by Mr. Herbert when he opportunely reminds us of Buckle's conclusions as to the effects wrought in France by Louis XIVth's patronage of science and art; individual thought and private enterprise were repressed, science and literature were put into bondage and reduced to a state of abject servility. It is this evil, however ridiculous the idea may appear to some, with which we are threatened here. In the field of geology the vast opera-

tions of the Government tend directly to dwarf individual research; geology itself tends to become a purely official science. "We confidently appeal," says Mr. Herbert, "to the best literary and scientific thought of the country to come to our aid and join us in the effort to effect a reform and arrest this pernicious tendency." It is needless to say that "The Popular Science Monthly" most cordially and earnestly indorses this appeal. If we want to preserve our intellectual liberty and encourage individual initiative, we must see to it that we do not establish any scientific pontiffs at Washington. And if in an unguarded moment we have established any such, and given them the means of stretching the arm of authority into every portion of our territory and laying the foundations of the Church of Official Science, the sooner we proceed to recall the powers so dangerously conferred, the better will it be for the commonwealth.

LITERARY NOTICES.

UPLAND AND MEADOW. A Poaetquissings Chronicle. By CHARLES C. ABBOTT, M. D. New York: Harper & Brothers. Pp. 397.

THE readers of the "Monthly" already know much of Dr. Abbott as a naturalist and antiquary; for he has not unfrequently visited our pages, bringing with him contributions, the fruit of his researches among the gravels of the Delaware, and of his rambles along the streams and through the swamps that happen to be near Trenton. An unreflecting reader might think, from the fullness of Dr. Abbott's budgets of Nature-lore, and the variety of interest which they contain, that there must be rare qualities in those particular gravel-beds and swamps, but the thought would not be justified. Presumably they are very much like the gravel-beds and swamps that may be found anywhere else, and the rare quality is in the observer. Dr. Abbott has also rare gifts at description, and the faculty of making his reader conceive the scenes and the curiosities almost as if he were along with his guide and looking at them. These merits of observing power and of description are well exemplified in this volume, which delineates what appear to be about a round year's rambles, with observations of animals and plants, and other objects of scientific interest. Keen observer as Dr. Abbott is, he found those things in the observations and histories of the old men he met that made him sorry that he could see so little, or that he had not lived in times when New Jersey nature was richer; he invariably wished, when he had talked with them, that he had been his own grandfather! Then there were men of his own time who could teach him better than he knew what to see. "To realize what a wealth of animal and vegetable life is ever at hand for him who chooses to study it, let a specialist visit you for a few days. Do not have more than one at a time, or you may be bewildered by their enthusiasm. I have had them come in turn—botanists, conchologists, entomologists, microscopists, and even archæologists. What an array of names to strike terror to the breasts of the timid!—yet they were all human, and talked plain English, and, better than all, were both instructive and amusing." The botanist found a plant not previously known to grow in New Jersey; the conchologist a diminutive bivalve with an enormous name, and microscopic shells whose tongues he had to examine and count their teeth; the entomologist chased insects with the speed of an express train, and caught kinds before unseen; the microscopist dipped up a pint-jar of muddy water, and, examining its contents at leisure, announced new infusoria, novel forms of imperceptible life, and gave to them startling names. So Dr. Abbott, in turn, resolved to be a botanist, a conchologist, a student of insect-life, a microscopist, and an archæologist. Even in winter, he finds Poaetquissings full of life; birds that are supposed to have gone away to the South chirping around and seemingly not troubled by the cold or by any lack of food; fishes under the ice; witch-hazels and chickweed and whitlow-grass and sassafras and alder and skunk-cabbage and dandelion blooming with the snow all around, and other flowers coming in as February and March advance. As the changing season proceeds, there are more

birds and more flowers, fields of various adventure, in climbing trees to get "bird's-eye views," and experiments on birds with looking-glasses in different positions, and with chromos of cats. Nest-building time affords subjects of interest that could not be exhausted in a whole life of observations; and, as the season warms up and passes into summer and then into autumn, and so on to the beginning of winter again, these objects multiply or hold their own, and the problem becomes one of how among so many to select the few that we can give proper attention to. Thus Dr. Abbott has always his eyes full. The plants and birds are with him all the time. Besides these, he keeps company with squirrels and rabbits, toads, crawfish, field-mice, and insects—till, as we close the book with the moaning of the October east wind in the sobbing pines, we are fully agreed with what he has told us in the beginning, that he has "seldom seen a half-acre that was not a 'Zoo,' which the study of a lifetime would fail to exhaust." The London "Academy" pronounces this volume "the most delightful book of the kind which America has given us," and says that "it closely approaches White's 'Selborne.'" Higher praise than that it would be impossible to give, and it is deserved.

FLOWERS, FRUITS, AND LEAVES. By Sir JOHN LUBBOCK. London and New York: Macmillan & Co. Pp. 147. Price, $1.25.

MR. RUSKIN has lately lamented a lack of books to teach him natural history. In speaking thus, he ignored some most excellent delineations of the natural world by putting them in a class of which he spoke with contempt, and overlooked others that he might have found. The three lectures embodied in this volume would be helpful to a man honestly making his search. They describe, in the engaging and thoughtful way which is characteristic of all of the author's writing about his observations, what is going on in one department of Nature for the promotion of a particular purpose of its being, and which is visible to every one who will attentively look for it. They present the results of studies of those points in the form, structure, color, and economy of flowers, fruits, and leaves which appear adapted to secure the sound life of the plant and the perpetuation of its species. In flowers, the most conspicuous feature is the adaptation to attract insects and secure cross-fertilization by their agency; whereby the insects, in turn, by fertilizing the largest and most brilliant flowers, have contributed unconsciously, but effectually, to the beauty of our woods and fields. "If seeds and fruits can not vie with flowers in the brilliance and color with which they decorate our gardens and fields, still they surely rival—it would be impossible to excel—them in the almost infinite variety of the problems they present to us, the ingenuity, the interest, and the charm of the beautiful contrivances which they offer for our study and admiration." Of leaves, it seems clear that the innumerable differences between them have reference, "not to any inherent tendency, but to the structure and organization, the habits and requirements of the plants. Of course, it may be that the present form has reference, not to existing but to ancient conditions, which render the problem all the more difficult. Nor do I at all intend to maintain that every form of leaf is, or ever has been, necessarily that best adapted to the circumstances, but only that they are constantly tending to become so, just as water always tends to find its own level. But, however this may be, if my main argument is correct, it opens out a very wide and interesting field of study, for every one of the almost infinite forms of leaves must have some cause and explanation."

POPULAR GOVERNMENT. By Sir HENRY SUMNER MAINE. New York: Henry Holt & Co. Pp. 261. Price, $2.75.

THIS work consists of four essays, in which the author, as he did in his "Ancient Law," undertakes to do away with the *a priori* theories conceiving a law and state of nature antecedent to all positive institutions, and a hypothetical system of rights and duties appropriate to the natural condition with which he believes the discussion of the subject has been hampered, and to apply the historical method of inquiry to them. In the first essay, which is on the "Prospects of Popular Government," he assumes to show that, as a matter of fact, that system, since its reintroduction into the world, has proved itself to be extremely fragile. In

the second essay, on the "Nature of Democracy," he gives reasons for thinking that, in the extreme form to which it tends, democracy is, of all kinds of government, by far the most difficult. In a third essay, on the "Age of Progress," he argues that the perpetual change which, as understood in modern times, progress appears to demand is not in harmony with the moral forces ruling human nature, and is apt, therefore, to lead to cruel disappointment or serious disaster. In the fourth essay, in which the Constitution of the United States is examined and analyzed, he aims to show that the birth of that law was in reality natural, from ordinary historical antecedents; and that "its connection with wisdom lay in the skill with which sagacious men, conscious that certain weaknesses which it had inherited would be aggravated by the new circumstances in which it would be placed, provided it with appliances calculated to minimize them or to neutralize them altogether." Its success, and the success of such American institutions as have succeeded, appear to him "to have arisen rather from skillfully applying the curb to popular impulses than from giving them the rein. While the British Constitution has been insensibly transforming itself into a popular government, surrounded on all sides by difficulties, the American Federal Constitution has proved that, nearly a century ago, several expedients were discovered by which some of those difficulties may be greatly mitigated, and some altogether overcome."

OCEANA; OR, ENGLAND AND HER COLONIES. By JAMES ANTHONY FROUDE. New York: Charles Scribner's Sons. Pp. 396. Price, $2 50.

MR. FROUDE'S mind has been occupied for many years with questions concerning the destiny of England and her colonies. Are they to remain substantially united, in spirit, aim, enterprise, and political structure, as they are now, each free to act for itself in its own concerns, but all combining for the propagation of Anglo-Saxon power and civilization, or are they destined to drop away from one another and become rivals? The question is one of great importance to Englishmen and to colonists, to us Americans as well as to them, and to all the world and all the friends of civilization and liberty. Many years ago, as a student of England's history, and believing in its future greatness, Mr. Froude imagined for himself the Oceana—a general Anglo-Saxon corporation—that might be. But, having no personal knowledge of the colonies, he could not make definite utterances, or form definite conceptions, concerning it; so he determined "to make a tour among them, to talk to their leading men, see their countries and what they were doing there, learn their feelings," and correct his impressions of what could or could not be done. He was then prevented from prosecuting his journey farther than to the Cape of Good Hope, and was not permitted to complete his design for ten years. "But," he says, "I do not regret the delay. In the interval the colonies have shown more clearly than before that they are as much English as we are, and deny our right to part with them. At home the advocates of separation have been forced into silence, and the interest in the subject has grown into practical anxiety. The union which so many of us now hope for may prove an illusion, after all. . . . However this may be, in the closing years of my own life I have secured for myself a delightful experience. I have traveled through lands where patriotism is not a sentiment to be laughed at," but an active passion, where "children grow who seem once more to understand what was meant by 'merry England.'" The book includes observations at sea, in the Cape Colony, in the several Australian colonies, New Zealand, and the United States, covering all the phases of the subject which was uppermost in the author's mind, besides many subjects not directly related to it. Of the United States, Mr. Froude expressses the opinion that "the problem of how to combine a number of self-governed communities into a single commonwealth, which now lies before Englishmen who desire to see a federation of the empire, has been solved, and solved completely, in the American Union." In logical conclusion, "it is something to have seen with our own eyes that there are other Englands besides the old one, where the race is thriving with all its ancient characteristics," and, "let Fate do its worst, the

family of Oceana is still growing, and will have a sovereign voice in the coming fortunes of mankind."

THE ADIRONDACKS AS A HEALTH RESORT. Edited and compiled by JOSEPH W. STICKLER, M. D. New York: G. P. Putnam's Sons. Pp. 198. Price, $1.

THE purpose of this work is to show the benefit to be derived from a sojourn in the wilderness, in cases of pulmonary phthisis, acute and chronic bronchitis, asthma, hay-fever, and various nervous affections. The author regards it as a fact that climate plays a very important part in the treatment of certain morbid states of the system, particularly in catarrhal affections of the respiratory apparatus and various forms of nervous disease. He relates as of his own experience that he obtained immediate and permanent relief in bronchitis from a sojourn in the Adirondacks. He also met, while there, several invalids who, having been in a precarious state of health, had been similarly relieved during their sojourn. He accordingly requested various persons, who had tried a change of climate as a means of regaining health, to give him honest expressions of their experience while in the region of the Adirondacks. This book is compiled from their letters as they were sent to him.

WHAT DOES HISTORY TEACH? By JOHN STUART BLACKIE. New York: Charles Scribner's Sons. Pp. 123. Price, 75 cents.

THE substance of this book was delivered in two lectures before the Philosophical Institution of Edinburgh, the first of which related to the lessons taught for the state, and the second to those taught for the Church. In the former category is the teaching that the family is the basis of the state and society. From the history of the downfall of Greece is drawn the lesson of failure and disaster brought about by the want of unity between the several states; from the fate of the Roman Republic that of the evil engendered by the perpetual conflict between the aristocracy and democracy. From these lessons and other examples, the author deduces a conclusion favorable to the security afforded by the English system, as preferable to what a democracy can offer; yet there may be an exceptional case in the United States, where "the experiment of a great democratic republic for the first time in the history of the world—for Rome in its best times, as we have seen, was an aristocracy—will be looked on by all lovers of their species with the most kindly curiosity and the most hopeful sympathy. Here we have the stout, self-reliant, sober-minded Anglo-Saxon stock, well trained in the process of the ages to the difficult art of self-government; here we have a Constitution framed with the most cautious consideration, and with the most effective checks against the dangers of an overriding democracy; here also a people as free from any imminent external danger as they have unlimited scope for internal progress. Under no circumstances could the experiment of self-government on a great scale have been made with a more promising start. No doubt they have a difficult and slippery problem to perform." To the Church are taught the lessons of avoiding controversy and of making religion practical.

TRANSACTIONS OF THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON. Vol. III. November 6, 1883, to May 19, 1885. Washington: Smithsonian Institution. Pp. 204.

THE number and scope of the papers printed in this volume, and the breadth of the discussions upon them, show the Anthropological Society to be an active body and earnestly interested in its work. A considerable number of the papers relate to American anthropology, a branch of the science to which this society may properly devote special attention, and for the study of which it has great advantages in the inclusion among its members of so many persons who are or have been connected with the geological survey. Many of the papers and the discussions upon them relate directly or indirectly to the mounds and the mound-builders, and frequently call up the question whether the mound-builders were identical with our Indians, or were of an earlier and superior race. Much may be found here to have been said on both sides of this subject. Among the other papers are some by Mr. Lester F. Ward from the mental side of anthropological study; an address by Mr. E. B. Tylor on "How the

Problems of American Anthropology present themselves to the English Mind"; an essay by Mr. F. A. Seeley on "The Genesis of Inventions"; and a presidential address by J. W. Powell on "From Savagery to Barbarism."

ESSAYS ON EDUCATIONAL REFORMERS. By ROBERT HEBERT QUICK. Syracuse, N. Y.: C. W. Bardeen. Pp. 330. Price, $1.50.

THE author takes for the motto of his essays the words of Dr. Arnold: "It is clear that, in whatever it is our duty to act, those matters also it is our duty to study." Being a teacher, he considers it his duty to study what has been done to advance the art of teaching, and this he does by studying the lives of those who have introduced new features into the work of teaching and examining their work. In the list are included the schools of the Jesuits, Roger Ascham, Montaigne, Ratich, Milton, Comenius, Locke, Rousseau, Basedow, Pestalozzi, Jacolot, and Herbert Spencer. While the author differs from Mr. Spencer in some of his conclusions, he agrees with him "that we are bound to inquire into the relative value of knowledges, and if we take, as I should willingly do, Mr. Spencer's test, and ask how does this or that knowledge influence action (including in our inquiry its influence on mind and character, through which it bears upon action), I think we should banish from our schools much that has hitherto been taught in them." In a chapter of "Thoughts and Suggestions" a consideration of the ordinary methods of school-teaching leads to the conclusion that in subjects other than classics and mathematics they are very commonly a failure, and a failure the teaching "must remain until boys can be got to work with a will—in other words, to feel an interest in the subjects taught." To this end, and to make the instruction serve its purpose, the effort should be made to teach things rather than words, and of things, not the dry details of the outside, but those points which concern their essence.

THE LATE MRS. NULL. By FRANK R. STOCKTON. New York: Charles Scribner's Sons. Pp. 437. Price, $1.50.

MR. STOCKTON is the author of "Rudder Grange," a short story, or episode, of domestic life, which has been commended in the "Monthly" as full of harmless though somewhat extravagant fun; and he is well known as the successful author of other sketches which furnish enjoyable—though idle—reading. In "The Late Mrs. Null" he attempts a more elaborate story, or "his first novel."

HOBBES. By GEORGE CROOM ROBERTSON. Edinburgh and London: William Blackwood & Sons. Pp. 240, with Portrait.

THIS is the tenth in the series of "Philosophical Classics for English Readers," by various authors, edited by Dr. William Knight, and has been preceded by volumes on Descartes, Butler, Berkeley, Fichte, Kant, Hamilton, Hegel, Leibnitz, and Vico. Whatever may be the merits of Hobbes's work, he has, as the author observes, left a broad mark in the history of the English mind. It is sought in this book to bring together all the previously known or now discoverable facts of his life, and to give some kind of fairly balanced representation of the whole range of his thought, instead of dwelling only upon those humanistic portions of it by which he has commonly been judged. The account of his "System" has been imbedded in the "Life," because, "more than of any other philosopher, it can be said of Hobbes that the key to a right understanding of his thought "is to be found in his personal circumstances and the events of his time." If a man's influence, the author observes in the concluding chapter of the book, and after having related the controversies he provoked, "is to be measured not least by the opposition that he arouses, we have already had proof that few thinkers have left a deeper trace upon their time than Hobbes." It was not only at home that he exerted influence or called forth strenuous hostility, but abroad as well. In England, so far as he has exerted an influence in philosophy proper, "it has been of the indirect kind wrought through psychological science. As psychology has a voice in the determination of ultimate philosophical notions that belongs to no other positive science, Hobbes has done more for philosophy by promoting the positive investigation of mental functions than by the abstract definitions of his own 'First Philosophy,' acutely conceived as these al-

ways were; when the accidental features of Hobbes's ethico political ideas—due to time and circumstances and personal temperaments—are discounted, it is not difficult to understand how it should have been philosophical results of the school of Bentham that first gave them effective currency"; and, finally, it should be said that, "with enemies and friends alike, Hobbes's power has been due not least to the rare excellence of his literary style."

APPALACHIA. March, 1886. Pp. 108. Price, 50 cents. REGISTER OF THE APPALACHIAN MOUNTAIN CLUB, FOR 1886. Boston: Appalachian Mountain Club. W. B. Clarke and Carruth. Pp. 40.

THE Appalachian Mountain Club was organized in January, 1876, and reorganized and chartered in April, 1878. Its objects, as specified in the By-Laws, are to explore the mountains of New England and the adjacent regions, both for scientific and artistic purposes; and, in general, to cultivate an interest in geographical studies. Its list of members has gradually grown, and now includes six hundred and ninety-three names of members of all classes. It is in relations of correspondence and exchange of publications with seventeen American societies and surveys, and fifteen Alpine clubs, and fifteen geographical societies abroad, besides single exchanges. Its periodical, "Appalachia," is usually published twice a year, four numbers constituting a volume. From the official reports, published in "Appalachia," it appears that the club held thirteen meetings during 1884—nine regular, two special, and two field meetings—the average attendance upon which was more than one hundred. The topographical department of the club is engaged upon a manuscript map of the White Mountains, on a scale of $\frac{1}{50000}$, from data already collected by members. Besides official reports, and reports of the meetings of the club, which themselves embody some papers of interest, the present number of "Appalachia" contains special papers on "The Tripyramid Slides of 1885"; "Earthquakes in New England"; "A Day in Flume Mountain and a Night in the Wilderness"; "Middlesex Fells"; "Accurate Mountain Heights"; and "Mountain Meteorology."

BULLETIN OF THE UNITED STATES FISH COMMISSION. Vol. V, for 1885. Washington: Government Printing-Office. Pp. 494.

WHILE the present volume of the "Bulletin" does not contain any long and elaborate monographs on some special branch of fish-culture like those which have given unusual value to some of the previous volumes, it is filled with numerous brief articles and extracts from correspondence, reporting progress, or embodying information of practical value. Under the heading of "A Foreigner's Opinion of American Fish-Culture," Sir Lyon Playfair is quoted as saying: "There is an essential difference between the mode of proceeding of the Government of the United States and that of our own country in relation to fisheries. We have had commissions without end, on some of which I have served. Vast bodies of contradictory evidence have been obtained from fishermen, who, I agree with Huxley, know less about fish than the community. Our commissions have led to little useful result. The American commissioners act in a different way. They put questions directly to Nature and not to fishermen. They possess scientific methods, and not those of 'rule of thumb.' They make scientific investigations into the habits, food, geographical distribution of fishes, and into the temperature of the seas and rivers in which they live or spawn. Practical aims and experiments are always kept in view."

THE ORDER OF CREATION; THE CONFLICT BETWEEN GENESIS AND GEOLOGY. New York: The "Truth-Seeker" Company. Pp. 178. Price, 75 cents.

THIS publication contains the articles by Mr. Gladstone and Professor Huxley which have already appeared in the "Monthly," together with Professor Max Müller's and M. Réville's replies to those parts of Mr. Gladstone's observations which bear upon what they have respectively said on the subject in controversy or upon theories to which they adhere; together with a reply by Mrs. E. Lynn Linton to a phrase used by Mr. Gladstone to convey his regret that some writers appear to him to rejoice at the thought that they have got rid of the belief in God.

WONDERS OF EUROPEAN ART. By LOUIS VIARDOT. New York: Charles Scribner's Sons. Pp. 335. Price, $1.

THIS volume is a translation of the second series of the "Merveilles de la Peinture," by M. Viardot, the first part of which has been already published as "Wonders of Italian Art" in Messrs. Scribner's series of "Wonders of Art and Archæology," to which this selection also belongs. It embraces notices of the Spanish, German, Flemish, Dutch, and French schools, in which M. Viardot has critically examined many thousands of the most celebrated paintings.

ELEMENTS OF UNIVERSAL HISTORY. By Professor H. M. COTTINGER. Boston: Charles H. Whiting. Pp. 336. Price, $1.50.

THIS history is designed for higher institutes in republics and for self-instruction. It presents the story in an easy, flowing style, adapted to attract and hold attention, and the matter is grouped in periods, at the close of each of which is a series of exercises and review questions. The author has failed to avail himself of the recent researches in extremely ancient history, without which no text-book even can now be considered complete, and the picture of Egypt and the Oriental monarchies, whose history is assuming definite form and importance, will be presented in erroneous colors.

SCRIPTURES, HEBREW AND CHRISTIAN. Arranged and edited for Young Readers. By EDWARD T. BARTLETT and JOHN P. PETERS. New York: G. P. Putnam's Sons. Vol. I. Pp. 545. Price, $1.50.

THE object of this work is to serve as an introduction to the study of the Bible. It is intended to be good for other than young readers; but the wants of that class have been especially had in view. The story is told in the words of the Bible, but with considerable condensation and rearrangement; the purpose having been to bring all that relates to a single event together, and to avoid repetitions. The compilers have endeavored to utilize the best results of critical scholarship; and the merit of what is called the "higher" criticism is recognized to an extent that might astonish some of the more obstinate sticklers for the old. The present volume contains the Hebrew story from the creation to the exile. A second volume will bring the account down to the time of Christ, and a third volume will be made from the New Testament.

THE STORY OF CHALDEA. By ZÉNAÏDE A. RAGOZIN. New York: G. P. Putnam's Sons. Pp. 381. Price, $1.50.

THIS history belongs to the "Story of the Nations" series, a series that is designed for the instruction of the young, and is also good for the old. The history of Chaldea has an interest of its own, because that nation competes with Egypt and China for the honor of being the most ancient nation of which any real historical record has come down to us. It has given us also the oldest positive authentic date in history—3800 B. C. for the date of the reign of Sargon I, as established in a record left by Nabonidus, the last king of Babylon. The present volume relates the history of this nation from the earliest times—the times preceding the dim age of Sargon—to the rise of Assyria, in which that other Sargon, mentioned by Isaiah, plays no unimportant part. The story itself is preceded by an introduction in which are given accounts of Mesopotamia and its mounds covering the ruins of ancient palaces and temples; Layard and his work; the ruins; and the grand library of Assurbanipal at Nineveh, in which are found accounts of that even then extremely ancient period which forms the main subject of the book, to which accounts the books of the Old Testament afford the only parallel.

DID REIS INVENT A SPEAKING TELEPHONE? Pp. 18. ON TELEPHONE SYSTEMS. Pp. 28. By Professor AMOS E. DOLBEAR, College Hill, Mass.

IN the first of these pamphlets, Professor Dolbear presents his own testimony and that of several other electricians and professors and students of physics of known reputation, based on their personal examination and experiments, to the effect that Reis's telephone embodied with considerable success the principle of the transmitter. The second pamphlet contains a lecture delivered before the Franklin Institute in December, 1885, in which the various systems of telephone construction and manipulation are examined and compared.

NOTES ON CERTAIN MAYA AND MEXICAN MANUSCRIPTS. By CYRUS THOMAS. Washington: Government Printing-Office. Pp. 64, with Plates.

THE manuscripts examined are the "Tableau des Bacab," a plate of the "Borgian Codex," and a plate of the "Fejervary Codex," all of which are supposed to be calendars. The symbols of the cardinal points are then considered in detail. The object of the study is to deduce some clew as to the connection of the Mayas with the other peoples of their region. On this point the author concludes: "That all the Central American nations had calendars the same in principle as the Mexican, is well known. This of itself would indicate a common origin not so very remote; but when we see two contiguous or neighboring peoples making use of the same conventional signs of a complicated nature down even to the most minute details, and that of a character not comprehensible by the commonalty, we have proof at least of a very intimate relation."

RAILROAD TERMINAL FACILITIES FOR HANDLING FREIGHTS AT THE PORT OF NEW YORK. By GRATZ MORDECAI. New York: "Railroad Gazette." Pp. 68, with Maps.

MR. MORDECAI presents a detailed study of the present terminal facilities of all the railroads centering in New York, with descriptions and maps, for the purpose of preparing a way for the consideration of how they may be improved; or how consolidated into a well-regulated and progressive combination; and he adds suggestions of some particular points in which improvement is desirable and feasible.

THE REQUISITE AND QUALIFYING CONDITIONS OF ARTESIAN WELLS. By THOMAS C. CHAMBERLIN. Washington: Government Printing-Office. Pp. 48, with Plate.

THIS is one of the papers of the United States Geological Survey. While the basal principles of artesian wells—by which are meant only those that flow at the surface—are simple, the real problems they present are complex. Success or failure is determined by a combination of various conditions rather than by the application of simple principles. It is the purpose of the paper to elucidate those conditions.

REPORT OF THE COMMISSIONER OF EDUCATION FOR 1883–'84. Washington: Government Printing-Office. Pp. 1214.

THE present report contains the usual fullness of special information concerning educational affairs in the United States, and general reports of those of other countries, down to June 30, 1884. The Commissioner remarks upon the improved character of the information brought to his office, and the growth of closer sympathy between the office and those actively engaged in educational work. It is observed that there has been no considerable improvement in methods or progress of education in any quarter of the country during the year to which the aid of the office has not been invoked. Clearer views and more intelligent counsels are also observable with respect to the most critical problems that have been under consideration. The total enrollment of pupils in the public schools of the States and Territories is 10,738,192, and in the private schools, 606,517; in secondary and preparatory schools, 271,215; in 236 women's schools, 30,587; in 370 universities and colleges (collegiate pupils), 32,767; in 255 normal schools, 60,063; in 221 business colleges, 44,074; in 354 Kindergartens, 17,002; in 92 schools of science, 14,769; in 146 theological schools, 5,290; in 47 law-schools, 2,686; in 145 schools of medicine, dentistry, and pharmacy, 15,300; in 31 training-schools for nurses, 579; in 59 schools for the deaf and dumb, 22,515; in 31 schools for the blind, 2,319.

A MANUAL OF MECHANICS. By T. M. GOODEVE. New York: D. Appleton & Co. Pp. 228. Price, $1.

THIS manual is designed to be an elementary text-book for students of applied mathematics. It consists of clear, condensed statements of the principles and problems of mechanical science. Elementary principles and definitions are given in an introductory chapter. The chapters that follow treat of "The Parallelogram of Forces"; "The Lever, Parallel Forces, and Couples"; "The Center of Gravity"; "The Conversion of Motion"; "The Principle of Work — Friction"; "Simple Machines"; "The Laws of Falling Bodies—Energy, Motion in a Circle, the Pendulum"; "Ele-

mentary Mechanism" (including the crank and connecting-rod, cams, the heart-wheel, escapements, ratchet-wheels, wheels in trains, the winch or crab, pulley-blocks, the steelyard, lifting-jack, etc.); "Truth of Surface, Strength of Materials, the Lathe"; and "Elementary Mechanics of Liquids and Gases."

EVOLUTION. By CHARLES F. DEEMS, LL. D. New York: John W. Lovell Company. Pp. 108. Price, 20 cents.

THE author—a well-known minister—whose training and mode of thought have been largely theological, professes that in his examination of the theory of evolution, of which this essay is a part of the fruit, he has endeavored to avoid all dogmatism and special pleading. "His aim has been to ascertain *for himself* just what is the posture of the hypothesis at this time, without much regard as to how it stood in the past, or any regard to its possible future, or any care for the effect which the result of his honest study might have on any scientific, philosophical, or theological opinion previously held by him." He assumes that there is no religious reason for the acceptance or rejection of evolution, and there are no valid sentimental objections to it; but the result of his investigation is the Scotch verdict, "not proven."

THE CHOICE OF BOOKS, AND OTHER LITERARY PIECES. By FREDERIC HARRISON. London and New York: Macmillan & Co. Pp. 447.

THIS volume consists of essays and lectures, written by the author at various times during the last twenty years, and which deal solely with books, art, and history, as distinguished from politics, philosophy, or religion; and which do not touch on any controversy except "the perennial problems presented to us by literature and the study of the past." About one third of the matter is in print for the first time. We have been interested in the essay which gives the name to the volume, and find it pregnant with valuable lessons. The burden of it is, that in the present multiplication of books it is impossible to master a fraction of those which may be helpful to us; then why should we waste our time over reading of any other kind? A short review of all literature, ancient and modern, follows, with hints as to the lots from which we can make the most judicious selections. Among the other "pieces" are a dialogue on "Culture"; "The Life of George Eliot"; "Historic London"; "The Æsthete"; "Bernard of Clairvaux"; "A Few Words" about the eighteenth and about the nineteenth centuries; and two articles—on Froude's "Life of Carlyle," and "Histories of the French Revolution"—which first appeared in the "North American Review."

POETRY AS A REPRESENTATIVE ART. By GEORGE LANSING RAYMOND. New York: G. P. Putnam's Sons. Pp. 346. Price, $1.75.

THE author of this essay is Professor of Oratory and Æsthetics in the College of New Jersey. The work, while it is complete in itself, in the sense that it develops from beginning to end the whole subject of which it treats, is in other senses only one of a series of essays which Mr. Raymond has written, respecting the various arts in their functions of representation, of which he gives a tolerably full list. He sustains the conclusion that while poetry is not, in a technical sense, a useful art, its forms have their uses, and many uses and practical ones, at the basis of which lies "the interpretation of the meaning of nature, natural and human, by those who have learned to interpret it, while striving to have it convey their own meanings." His points and principles, as he deduces them in detail, are copiously illustrated with citations from the poets.

THE FISHERIES AND FISHING INDUSTRIES OF THE UNITED STATES. By GEORGE BROWN GOODE, and a Staff of Associates. Washington: Government Printing-Office. Section 1, Text. Pp. 895. Section 2, 277 Plates.

THIS elaborate report has been compiled under an arrangement between the United States Fish Commission and the Census Bureau, to prepare as exhaustive an investigation of the objects of the work as possible. The scheme of the investigation as drawn up by Mr. Goode embraced the natural history of marine products; the fishing grounds; the fishermen and fishing towns; apparatus and modes of capture;

products of fisheries; preparation, care, and manufacture of fishery products; and economy of the fisheries. The present volumes relate to the natural history of aquatic animals. For the preparation, the coast, lakes, etc., of the country were mapped off into twenty-four districts, each of which was assigned to a "field assistant" investigator; while another body of assistants were employed in the office.

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Corthell, E. L., C. E. Exposition of Errors and Fallacies in Rear-Admiral Ammen's Pamphlet on Nicaragua Canal and Eads Ship Railway. Washington: Gibson Brothers. Pp. 52.

Jameson, J. F., Ph. D. Introduction to the Study of the Political and Constitutional History of the States. Pp. 37. Randall, D. B. A Puritan Colony in Maryland. Pp. 48. Baltimore: N. Murray. 50 cents each.

Martin, H. N., and Brooks, W. K. Studies from the Biological Laboratory of Johns Hopkins University. Vol. III, Nos. 5 and 6. Pp. 48 and 84, with Plates. 50 cents and 60 cents.

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Bulletins of the United States Geological Survey, No. 24. List of Marine Mollusca. Pp. 336. No. 25. Present Technical Condition of the Steel Industry. Pp. 85. No. 26, Copper-Smelting. Pp. 107.

Lewis, T. H. Ancient Rock Inscriptions in Eastern Dakota. Pp. 8, with Plate. The Monumental "Tortoise Mounds" of "Decoodah." Pp. 5.

Richards, Edward. Principles and Methods of Soil Analysis. Washington: Government Printing-Office. Pp. 66.

Munroe, Charles E. Notes on the Literature of Explosives. No. 10. Pp. 18.

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Mays, Thomas J. The Analgesic Action of Theine. Pp. 28.

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Transactions of the New York Academy of Sciences. February, 1886. Pp. 16.

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Superintendent H. A. Kinney and others. Outlines and Suggestions to the Teachers of Harrison County, Iowa. Missouri Valley, Iowa. Pp. 26.

Sabbrin, Celin. Science and Philosophy in Art. Philadelphia: William F. Fell & Co. Pp. 21.

Dolbear, Amos E. On the Conditions that determine the Length of the Spectrum. Pp. 2.

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Hall, G. Stanley, and Jastrow, Joseph. Studies of Rhythm. Pp. 8.

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Walloth, Wilhelm. The King's Treasure-House. A Romance of Ancient Egypt. New York: W. S. Gottsberger. Pp. 353.

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Outlines of Geology. By James Geikie, LL. D., F. R. S. London: Edward Stanford. 1886. Pp. 427, with 400 Illustrations.

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Behrends, A. J. F., D. D. Socialism and Christianity. New York: Baker & Taylor. Pp. 308. $1.50.

Macleod, Henry Dunning. The Elements of Economics. Vol. II, Part 1. New York: D. Appleton & Co. Pp. 376. $1.75.

POPULAR MISCELLANY.

The Chicago Public Schools.—Mr. James R. Doolittle, Jr., President of the Board of Education of Chicago, in his report for the school year 1884–'85, considers briefly but with vigor many interesting points in connection with the school system of that city, which are well worth the attention of school officers generally. He regards the school as a progressive institution, which should look to the future rather than to the past, and, while it takes advantage of all that has been gained, should be on the watch to discover whatever may help to make it more efficient in accomplishing its object—which should be to give youth facility to adjust themselves to the duties and exigencies of life. The board has determined that every one of the grammar-schools shall have a library, concerning the constitution of which the President remarks: "None of the books should be beyond the ordinary capacity of grammar-school children. In fact, they should be much easier to comprehend and master than the other books of the course, otherwise the library would fail to attract the children. None of the books should contain anything the children ought not to read, and none should be so difficult that they may not be read with pleasure and interest." The president is justly alarmed at the increase of near-sightedness with the advance of age in the school, the rate of which is shown to rise in Chicago from 4·09 per cent at six years of age in the Ogden School to 27·08 per cent at twenty years in the North Division High-School; but he can suggest no remedy except improved lighting and the most legible text-books. Concerning "practical education," a wholesome conservatism will serve as the sheet-anchor of safety. . . . The principal object of education is to instruct the pupil how to learn; to enable him to comprehend, in a way, the new things which encounter him when his school days are over. Up to this point, which, in the case of the child educated in the common school, will never be very high in an educational aspect, all the pupils should go, boys and girls alike. Drawing and book-keeping in its simple form might well be taught, for they are useful to every one. It is lamentable that nothing is taught, short of the high-school, concerning the organs and functions of the human body. A considerable portion of the work required of the pupils appears highly artificial, and of questionable utility. A tendency is observed to teach a mass of unimportant facts, which the pupils will certainly, and had better, forget, and a disposition to compel them to absorb and assimilate ideas beyond the ordinary comprehension of childhood. These things "may furnish an opportunity for precocity to shine, but do not facilitate the normal development of the intellectual powers." The practice of ascertaining the relative standing of pupils by the rapidity with which they answer questions, or perform certain operations, is highly un-

just and fallacious. "The standing of pupils should be established by the degree of thoroughness attained in their respective acquirements; that is the test of men in practical life, and it should be the same in school-life." The higher mathematics and the dead languages have received too much attention, because the fruits are of meager value and limited utility; but "more time should be spent in our schools in giving instruction in English words and expressions." The standard of English study should be raised everywhere.

Principles of Sea-Bathing.—Sea-bathing, when properly and carefully indulged in, is a most health-giving and enjoyable diversion. But a few broad principles should be remembered. Never bathe within two hours of a meal, never when overtired and exhausted, and never when overheated. At the same time the body should be warm, and not cold, when you plunge in. Do not remain in the water long enough to become tired or chilly, and when you come out dress quickly. It should also be remembered that bathing does not agree with everybody. Those who feel faint or giddy in the water, or whose hearts begin to beat overmuch, should consult a doctor who is thoroughly acquainted with their constitutions, before they enter the water again. Medical papers say that many of the bathing fatalities which have been generally attributed to "cramp" are really due to failure of the heart's action, induced by the plunge into cold water, and aggravated by swimming. A good result of the bath ought to make the bather feel warm and fresh. If, instead, shivering and cold ensue, harm is being done. Children should not be forced into sea-baths, for their reluctance may be occasioned by some constitutional drawback, testifying that the process is harmful to them.

The American Economic Association.—The American Economic Association has been founded by the co-operation of a number of students of that subject, for the encouragement of economic research, with the publication of monographs and the promotion of perfect freedom of discussion. It starts with the belief that political economy as a science is still in an early stage of its development; that its advance is to be sought through the historical and statistical study of actual conditions of economic life rather than through speculation. It recognizes that the conflict of labor and capital has brought into prominence a vast number of social problems, whose solution requires the united efforts, each in its own sphere, of church and the state. Without taking any partisan attitude in the study of the industrial and commercial policy of governments, it believes in a progressive development of economic conditions, which must be met by a corresponding development of legislative policy. Among the topics which are suggested as proper subjects for reports by the standing committees, are the employment of women in factories; municipal finance; rent in the United States; the National Railroad Commission; limitation of suffrage as a remedy for abuses in local administration; the effect of transportation on the laborer; and the silver question. The President of the Association is Dr. Francis A. Walker, of the Massachusetts Institute of Technology; the Secretary is Richard T. Ely, Ph. D., of Johns Hopkins University.

Parsee Funerals.—As soon as the case of a Parsee about to die is seen to be hopeless, he is washed all over in *gomez* (ox's urine), and dressed in clean clothes, while the priests repeat prayers and Avesta texts. When life is extinct, the feet are tied together, the hands are joined, and the body is laid on the ground-floor. A priest remains by it, saying prayers and burning sandal-wood, till the bearers come to take it to the *dakhma*, or "tower of silence." As soon as the bearers arrive, the seven parts of the Ahurian hymn are chanted, to combat the power of death, which has come from hell to seize the corpse and threaten the living. When this is over, the body is taken off by the bearers on an iron bier to the *dakhma*, where it is exposed, "clothed only with the light of heaven," to the vultures, which will strip it to the skeleton in about an hour. The skeletons soon become perfectly desiccated, and are then thrown into the deep central pit of the tower, where they crumble and are washed away by the

rains. The object of exposing the bodies in this way is said to be to avoid polluting the earth by burying them. Throughout the Zoroastrian writings that remain, this principle is continually dwelt upon. Cremation is even a greater crime than interment of the dead, because, it was alleged, of the exceeding holiness and purity of fire, which must not be polluted. These views, it has been suggested, originated in the abhorrence of primitive Zoroastrianism for cannibalism and human sacrifices, on account of which it surrounded the dead human body with such awful horrors and observances as should effectually defend it against them.

The Flying Force of Birds.—Dr. Karl Müllenhoff has published, in the proceedings of the German Society for the Advancement of Aëronautics, a paper on the force exerted by birds in flying. The latest calculations, by Marey and others, give the maximum force exerted by birds at 1·2 to 1·4 kilogramme per square centimetre of muscular section—numbers that are not greater, but rather less, than those which represent the strength of other animals. Dr. Müllenhoff deduces from his own calculations that the labor performed by the wing in any time-unit is little if any greater than that involved in walking on the ground. This result agrees with the facts shown by experiments that the weight of doves was not changed after considerable test-flights; and that it fell off only a few grammes after a flight of three or four hundred kilometres. Quite different from this are the results afforded by the experience, say, of velocipedists; one of whom confessed to the author that he had lost ten pounds after a few months of cycling, and who suffered after an hour or so of his exercise from a greatly quickened pulse and an intense heart-beating. Prechtl, of Vienna, some years ago published the conclusion that the force exerted by birds in changing their place was not greater than that of the other animals, and that the amount of force exerted by large and small birds was relatively the same. Helmholtz, twenty-seven years later, came to an opposite conclusion, which he based, however, only on theoretical grounds. He predicated a geometrical similarity in the forms and movements of smaller and larger animals, and that a greater increase in power must be given the larger animals to overcome the greater resistance they have to encounter. Dr. Müllenhoff having subjected this theory to an experimental test, has found it not sound. The geometrical similarity of motions does not exist. While the wings of the larger birds move up and down, those of the smaller birds move diagonally, and of the smallest nearly horizontally. The author having also examined the rate of increase of velocity corresponding with increase of size, separately as regards vertical and horizontal movements, finds that increase in the weight of the body is not accompanied by increase in the relative muscular mass; that the amount of absolute force does not increase as the bird becomes larger; that no differences are apparent between birds of different sizes in the velocities of the muscular contractions; and that, regarding differences in the quantity and quality of the food consumed by the larger and smaller birds—concerning which there is question—while the labor performed in flight can be furnished only at the expense of a corresponding consumption of chemical elasticity, we can so far not make any definite declaration concerning either the amount of substance consumed in flight-work, or the amount of food required to compensate for the substance that is consumed.

The Problem of the Irrawaddy.—Mr. Robert Gordon, who has recently addressed the Royal Geographical Society in support of his theory that the Irrawaddy is the outlet of the Sanpo of Thibet, says that that river presents the greatest geographical problem in Asia. Mr. Gordon's view is contradictory of the opinion generally held by geographers that the Sanpo is the Brahmapootra, a river that it must meet or run around before it can reach the Irrawaddy. In favor of his theory, he adduces the testimony of a number of Thibetan and Chinese authorities, dating from times of considerable antiquity; the size of the Irrawaddy in its upper course, which can not be supplied by the few small streams and the limited water-shed the geographers give it; the testimony of the names of various rivers and branches of rivers in

the debatable region; and the opinion of a number of geographers and travelers who do not agree with the majority. Moreover, the Brahmapootra does not need the Sanpo, and the Irrawaddy does. Mr. Gordon's views were strongly controverted by General J. T. Walker and other experts in Indo-Chinese geography.

Distribution of an Insect Species.—The *Anonia plexippus*, an American butterfly, is now engaged in distributing itself over the world. It is extending itself both eastwardly and westwardly. Its natural range appears to be from the Hudson Bay Territory to the Amazon and Bolivia; but some thirty or forty years ago it began to wander. It has established itself and become abundant in the Sandwich Islands. The first specimens were observed in the Marquesas Islands, by a Roman Catholic missionary, about 1860. It is now the commonest butterfly there. It has appeared in the Society, Cook, Harvey, Samoan, Friendly, and Feejee Islands, the North Island of New Zealand, Norfolk Island, Australia, Tasmania, the New Hebrides, Solomon Islands, New Guinea, Celebes, and Java; and it was abundant in New Caledonia a few years ago, but has become more rare there. In the eastward direction it has made its way to the West Indies, has been long established in Bermuda, furnished one specimen in the Azores in 1864, was found in South Wales in 1876, at La Vendée—the only specimen yet found on the Continent of Europe—in 1877, and in Kent in 1881.

Uses of Liquid Carbonic Acid.—The liquefaction of carbonic acid was at first a mere scientific curiosity, and only a few are probably as yet aware that it is much more. But a German firm, Messrs. Raydt & Kunheim, have devised an apparatus for producing the liquid, and are producing it in large quantities for industrial purposes. It is used for charging beer in the cask; and in the manufacture of seltzer-waters the gas is more easily and effectively introduced from a vessel containing the liquid than in the old-fashioned way. It has been found very valuable for the service of fire-extinguishers. The Krupps, of Essen, use it for producing compact castings. For this purpose the mold is closed as soon as the metal has been introduced, and is connected by a valve with the vessel containing the liquid acid, the pressure of the gas from which is augmented by heating it in a salt-water bath. The Krupps have found that a heat of 360° will give the colossal pressure of twelve hundred atmospheres. Another application of the liquid proposed by Dr. Raydt is to the raising of sunken ships by means of the gas from it. Compressed air has long been employed for this purpose, but it requires a costly apparatus that may be done away with if liquefied carbonic acid is substituted for it. In some experiments made at Kiel, a stone weighing three hundred quintals was raised, by means of a balloon filled with carbonic acid, from a depth of thirty feet to the surface of the water in eight minutes.

Travel by Balloon.—Mr. William Pole insists, in "Nature," that the feasibility of balloon navigation has been made very highly probable by the recent French experiments. M. Tissandier, in 1883, obtained with his dirigible balloon a velocity of nine miles an hour. The French military authorities then commissioned two of their officers, Messrs. Renard and Krebs, to work the problem further out. They obtained an independent velocity through the air of upward of thirteen miles an hour, with a balloon which was managed, steered, and guided with the greatest ease, and was made to return to its starting-point in defiance of the wind. Careful calculations, made according to the rules of M. Dupuy de Lôme and Professor Rankine, of the resistance afforded by the air and the efficiency of the screw-propeller, show that the attainment of considerably higher speeds is perfectly practicable. A balloon of fifty feet diameter, for example, would carry power sufficient to give a speed of upward of twenty miles an hour, and still leave a considerable buoyancy disposable.

Colors of Swedish Eyes.—Professor Wittrock read a paper before the Swedish Anthropological Society on the investigations into the hereditability of the color of the eyes, which he had undertaken at the instance of Professor Alphonse de Candolle. These results differed from those which

Professor de Candolle had published for Switzerland, North Germany, and Belgium. Brown eyes were more common among women than among men. From the fact that 56 per cent of the children of parents who were bi-colored (or one of whom had brown and the other blue eyes) had brown eyes, it appeared that eyes of that color were on the increase. The majority of wives had brown eyes. The average number of children of con-colored parents was 4·49, and that of bi-colored parents 4·03—contrary to Professor de Candolle's observations, which gave the larger number to bi-colored parents. It also appeared that 52·6 per cent of the children inherited the eyes of the father and 47·4 per cent those of the mother; of the sons, 51·8 per cent inherited the father's, and 48·2 per cent those of the mother, while the figures with regard to the daughters were respectively 53·5 and 46·5 per cent. These figures show that in Sweden the eyes are not predominantly inherited from the mother alone, and that the offspring of equally constituted parents should not be weaker than they. Children under ten years of age were excluded from the examinations, and blue-gray and gray eyes were classified as blue.

Causes of the Extinction of Species.—Professor A. S. Packard has published an article in the "American Naturalist" on some of the apparent causes of the "Geological Extinction of Species." He reviews at length the factors of changes of climate to which he ascribes the most extensive phenomena of the kind. In the palæozoic ages, the climate of the whole earth was nearly uniform, and species were very widely diffused. Upheavals of mountain-ranges and continental masses, taking place at different epochs, produced more or less marked differentiations and local conditions favorable to some species and unfavorable to others, with the result that some flourished while others declined and faded out. The glacial epoch, bringing great changes of climates, produced also many revolutions in the relations of species. Changes in altitudes, marked on the American Continent by the elevation of the Rocky Mountain and Andean districts to from five thousand to ten thousand feet, the workings of which are still going on to a certain extent, also materially affected those relations; and similar changes have occurred in the other quarters of the world. "The biological changes were not due to climatic and geological changes alone, but it should be borne in mind that the great changes, slowly induced, but not without striking final results, ending in the addition or loss of vast areas of land, induced extensive migrations, the incursions of prepotent types which exterminated the weaker. The reaction of one type of life upon another, the results of natural selection, were apparent all through; but these secondary factors were active both during periods of quiet and periods of change. . . . Local extinctions due to local changes of level; the formation of deserts, saline wastes, and volcanic eruptions and vast outpourings of lava, such as took place in Oregon and Idaho during the Tertiary, with submarine earthquakes causing the death of fishes on a vast scale, these are quite subordinate factors."

Toad-Lore.—Toads have much in common with frogs, but they are hatched from spawn that is deposited in long strings, while frog-spawn is in masses, and they have no teeth. They are also marked by ugly warts, which give out an acrid but not poisonous juice. They have tongues whose motions, nearly as quick as lightning, the eye can not follow, and which sweep in the insects they catch with such speed that the victims "seem to melt into thin air" rather than to be caught and swallowed. They can climb plastered and whitewashed walls or flights of steps, and even into flower-pots whose outward sloping sides would seem to forbid such an achievement. They will eat nothing that is not in motion except their own skins, which, when they are cast off, they roll up and swallow. The muscles of their thighs and legs strikingly resemble those of man. They can not breathe when their mouth is held open. The old necromancers used them freely and in various ways in their magic. In some parts of England the application of a toad is supposed to stop bleeding, and dried specimens are worn as charms against rheumatism. The members of a Devonshire family had a reputation for curing "king's

evil" by means of toads. Some of the German peasants are said to have a way of crucifying toads, which must be caught for the purpose on Easter-Sunday morning before sunrise; then burying them in an ant-hill, and leaving them there till Whitsunday, when their clean and white bones, worn in a little bag around the neck, will always make the possessor win in games of chance. The Thibetans, according to Abbé Huc, tell of a toad that dwells amid the mists of a lofty mountain-range, and, unless he is propitiated, flings ice and avalanches down upon those who pass in the valleys below.

Cuban Storms.—The "Meteorological Annual" of the Royal College of the Society of Jesus at Havana, for 1875, which has only recently been published, contains several instances of coincidences between Cuban storms and meteorological phenomena in the United States, and particularly of seeming relations with magnetic manifestations. During three days in April—3d, 4th, and 5th—a "norther" prevailed, and was succeeded on the three following days by a remarkable magnetic perturbation, which was accompanied with a high barometer and a strong wind, with daily manifestations of aurora in the United States, but without accompanying electric phenomena. A magnetic perturbation on the 13th of April was coincident with a norther, much thunder and lightning, a very heavy rainfall and a disposition and state of the aqueous vapor which gave rise to solar and lunar halos, and other optical effects; but during the time no auroras were reported from the United States. Father Viñes, the compiler of the "Annual," points out various other relations between the magnetical and meteorological phenomena which suggest that this line of inquiry is likely to lead to valuable additions to our knowledge of weather-changes. The diurnal and seasonal fluctuations of the barometric column in their varying amounts are significant in their relations to the analogous phenomena in the United States and over the high-pressure area of the Atlantic. For four days previous to the observation of the highest temperature of the year—July 30th, at 4 P. M., 98·8°—auroras had been observed in the United States, and the magnetic and electrical conditions showed marked disturbances at Havana. Of eighty recorded thunder-storms, sixty-five occurred during the five months from May to September, and only three during the four months from January to March, and December. This almost total absence of thunder-storms from the rains of the winter months, as compared with the summer months, when lightning or some other electric phenomenon occurs almost daily, is important in its bearing on the theory of the thunder-storm.

A New Species of Box-Wood.—A new species of box-wood has been discovered growing in the neighborhood of the Cape of Good Hope and in Caffraria, and a quantity of it has been sent to the English market. The first sample specimens that were sent were marred by defects in the grain, which made them of inferior quality for engraving purposes. A second and larger lot appears to promise better, for it is said of it that the logs are of good sizes, sound, and clean grown. The wood possesses a closeness equal to the best Abassian box-wood, and it is thought will suit admirably for engravers' purposes. It appears to be one of the best hard woods that has yet been put forward as a substitute for genuine box-wood. The new species very closely resembles *Buxus sempervirens*, and has been named *Buxus macowani*.

The Spectroscope and the Elements.—Professor Balfour Stewart, from an examination of the evidence afforded by the spectroscope as to the nature of the elements, concludes that it is, on the whole, in favor of their being in reality compound structures, the components of which possess attractions for each other vastly greater than those exhibited in ordinary chemical combinations. The fact that in the hottest stars we have the fewest atomic structures is also in favor of this hypothesis. Summing up the evidence derived from both terrestrial and celestial sources we have, first, experimental evidence of various kinds, tending to show that the so-called elements are not essentially different from other bodies; second, in the terrestrial spectrum of pure metals at a high temperature, certain lines are obtained for some one ele-

ment that are extremely near, if not coincident, in spectral position with those obtained for some other element or elements: these have been called basic lines; third, we know that in the sun's atmosphere there is a process at work tending to separate the various molecular and atomic structures, and we find that the greater number of the lines given out from the sun's hotter regions are basic lines, such as are above defined; fourth, in the very hottest stars, where the dissociation is greatest, we have only a few prominent lines given out, these being lines belonging to hydrogen, calcium, and magnesium. "I think," Professor Stewart adds, "we must conclude that the hypothesis that the elements are in reality compound bodies offers, with our present knowledge, a very good and simple explanation of the results of spectroscopic analysis in the earth, the sun, and the stars."

NOTES.

In Professor Jordan's sketch of Rafinesque, in the June number of the Monthly, page 216, "Hendersonville," Kentucky, should have been "Henderson." The correction was duly marked by the author, but failed to reach our press-room.

The thirty-fifth annual meeting of the American Association for the Advancement of Science will be held at Buffalo, New York, August 18th to 24th. Professor E. S. Morse, of Salem, Massachusetts, will be the president of the meeting. The Secretary of the Association is Professor F. W. Putnam, of Cambridge, Massachusetts.

The meeting of the British Association is to be held this year at Birmingham, under the presidency of Sir William Dawson. The sectional presidents will be: Section A (Mathematical and Physical Science), Professor G. H. Darwin; Section B (Chemistry), Mr. W. Crookes; Section C (Geology), Professor T. G. Bonney; Section D (Biology), Mr. W. Carruthers; Section E (Geography), Major-General Sir F. J. Goldsmid; Section F (Economic Science and Statistics), Mr. J. Biddulph Martin; Section G (Mechanical Science), Sir James N. Douglas; Section H (Anthropology), Sir George Campbell, M. P.

George Roberts, of Lofthouse, England, relates in "Science Gossip" that, having found two white slugs under some stones, he placed them on a green leaf, when they became in a few minutes of a greenish color.

In our notice of Mr. Scely's "Genesis of Inventions," in the May number of the Monthly, an error of the press made us give to the new branch of study which the author proposes the name of *Eunematics*, which has no significance, for *Eurematics*, the real name, which is a legitimate derivation from the Greek, and is appropriate.

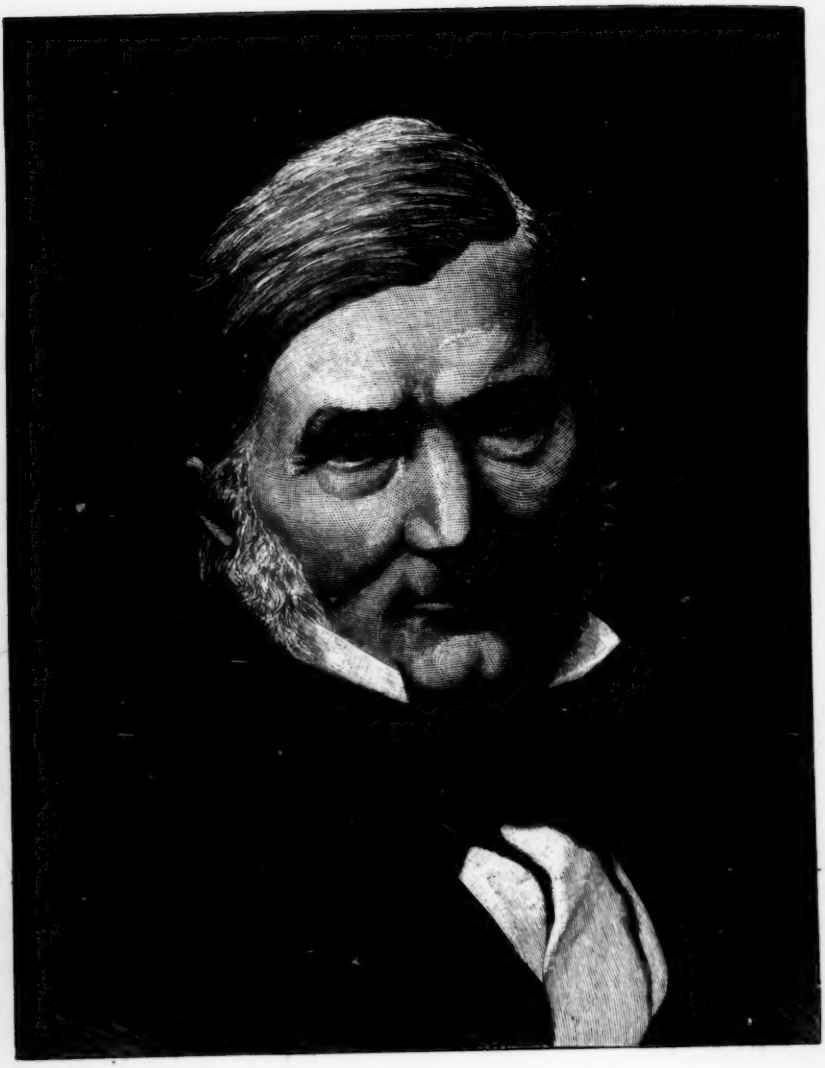
The Committee of the American Ornithologists' Union, on the "Protection of North American Birds," seeks to gather and diffuse all possible information on the subjects of the destruction and the protection of North American birds, and the utility of birds; to encourage the formation of bird protective associations, and anti-bird-wearing leagues; to secure the perfection of suitable, practicable statutes in all the States and Territories for the protection of birds; to prevent the collecting of birds and eggs for pseudo-scientific purposes; and to consider the best means for securing the enforcement of bird-protective statutes. The headquarters of the committee are at the American Museum of Natural History, Central Park, New York city. Mr. George P. Sennett is its chairman, and Mr. Eugene P. Bicknell its secretary.

The Rev. Canon Charles Lett used to relate, in illustration of the reasoning power of the bird, that a gentleman in Waterford, Ireland, had, in 1828, a tame golden eagle, which was allowed the freedom of the yard and garden. The owner once, for amusement, placed the house-cat near the bird, which attempted to seize it and met the usual fate of too close assailants of cats. A chicken was next brought, and instantly pounced upon. The owner, however, released it, whereupon the eagle hopped clumsily after it, but could not overtake it. The bird then turned against its owner and attacked him with vigor, as if in revenge for being deprived of its prey.

Up to the middle of April, M. Pasteur had treated about seven hundred and fifty patients with his remedy for hydrophobia, with what is considered a very gratifying success. In some of the cases the patients may not really have received the virus, or the dog may not have been really mad; and six out of thirty-eight Russians who had been bitten by a rabid wolf died. But, when allowance is made for these, enough is left to give the seal of validity to the claims which the eminent practitioner sets forth for his remedy.

"Land and Water" publishes, and credits to a "local paper," a story told by a Scotch railway-laborer, who saw a hawk swoop upon a blackbird which was singing on a bush by the side of the river Ettrick. The blackbird, he says, was at once unperched and carried to the ground, strug-

gling and screaming in the talons of its [illegible] drop'



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